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## ELECTRICAL REVIEW

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TO ADVERTISERS

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NEW ADVERTISEMENTS should be in the office not later than Monday noon to insure publication in that week's issue.

The business of the electric light central station at this season of the year grows small and indicates it as the time for making repairs, enlargements, changes and alterations of all sorts. Very many of the electric light plants in this country have grown so rapidly and been so crowded with business that they have never had time to perfect their physical equipment. There is an abundant opportunity all over the country for the tearing out of old and antiquated apparatus, the redesigning and planning of stations upon modern lines, the installation of new systems and the general overhauling of apparatus and lines. Managers should not be slow to avail themselves of the semi-holiday which the summer brings to get in hand such improvements as are indicated above.

### *A SUCCESSFUL EXPERIMENT.*

In no direction of human activity is conservatism more marked than in the operation of railroads. This is due without doubt to the extraordinary complexity of railway operation in general and to the innumerable elements which enter on both sides of the ledger and go to the making of a profit or a loss. Railroad men, of all classes, seem most prone to adhere to the tradition of their craft and to do things as they have been done before, avoiding religiously innovations or improvements.

For this reason electricity as a motive power for main line railroads has made slow and not altogether gratifying progress. It has taken a newly constructed railroad to provide a field for experiment on a large scale with electric traction. Such an experiment, or perhaps we should better say application, has been made on the line of the Albany & Hudson Railway and Power Company, which is described at some length on other pages of this issue. This railway has now been in operation without interruption or trouble for some time and has progressed far enough to enable the collection of data relative to train operation by electricity on a scale little inferior to that of the ordinary steam railroad.

The success of the enterprise has been even more gratifying than was hoped for by its originators. It was known, of course, that the cars would move over the railway and that there would probably be no serious engineering difficulties in the way of maintaining a schedule and operating trains in all seasons of the year. It was not foreseen, however, so clearly as has been demonstrated by the event that the earning power of such a system is high. By the use of water power and a well-planned station and well-designed line the labor and material cost of a kilowatt-hour delivered to the transmission line has been reduced to a point approximating one-half a cent. With frequent trains the load is well distributed and power is generated at high economy. The service is satisfactory to patrons of the road as well as to its management, the speed is high, and the elaborate and careful system of despatching in use renders the system safe. It is already beginning to build up industry and encourage travel in the district that it serves and, upon the whole, it may be regarded as a highly successful solution of a difficult traction problem.

Doubtless the managements of many other railroads, inspired by the conservatism of which mention has been made above, have awaited the outcome of operation on this line with peculiar interest. To those who are operating interurban lines of moderate length, say up to 100 miles, a study of the conditions, the costs and the traffic on the Albany & Hudson Railroad will be of great value as well as of peculiar interest. It is hoped, as it is believed, that this line will be a forerunner of the many similar ones, and that the equipment of steam railroads may progress when it has begun in much the same way as did the electrical equipment of horse-car lines in cities. Many of us can remember to this day the conservatism that caused the owners of horse railroads once to pooh-pooh the trolley car as a visionary experiment utterly unsuited for the use of their particular service.

### *ELECTRICAL WORK AND THE HOT WEATHER.*

It is very gratifying to notice that despite the hot weather of the present season, electrical activity, as manifested by the records of the Patent Office and the incorporation of companies throughout the country, seems to be progressing as steadily and as satisfactorily as ever. One needs only to turn to the weekly list of patents granted and incorporations filed, which are printed in other columns of the ELECTRICAL REVIEW, to note that there is no cessation apparently in these directions of activity, and that every indication shows electrical business to be as progressive now as at any time in the last several years. Or-

dinarily it is customary for business of all character to show a decided decline in the warm months of July and August. People are then taking their vacations and only perfunctory work is done, as a general thing. This was not the case last summer, however, and does not seem to be this summer. We are too busy to stop working and take vacations, although it is probably true that the business men in the profession are better able financially to take a period of recreation this summer than they have been before for many years.

What makes the situation even more pleasing and interesting is that the outlook is as good as the actuality. We are not only very busy and shops and factories are not only working full time (and often overtime) but it seems as if this condition of things would keep up, from present appearances, at least, indefinitely. The extraordinary extension of foreign markets which has followed as the result of the war with Spain and the enlargement of ideas that have come to us with the acquisition of new possessions has given a new outlet for our manufactured products. While some of our manufacturers have been slow in taking advantage of the opportunity afforded by these markets, still a great deal of American electrical apparatus is going abroad and at the same time there is a gratifying demand for it at home. New enterprises, such as the building of electric railway lines and the exploitation of electric lighting systems, need the fertile surroundings of good times. When panic is imminent and money is hard to get such enterprises are shelved to wait for a more convenient season. To a certain extent they form an excellent barometer of general business conditions and reflect the status of commerce in all its various branches. This is a good year for the electrician, whether he be engineer, manufacturer or workman.

### *TELEPHONES FOR TRAIN DESPATCHING.*

The use of the telephone for train despatching purposes is rapidly increasing. Tested at first upon suburban lines and upon electric railway lines running into suburban districts, it has gradually come to be used on steam railways, at first on branches and now on more important lines. It has just been announced that the Delaware, Lackawanna & Western Railroad, an important system of railroads running northwesterly from New York to Buffalo, will introduce telephones for despatching for all of its work on its main lines during the course of the next few months. The telegraph will be superseded for this purpose and it is believed that a considerable reduction in expenses will be made by saving the salaries of the telegraph operators now employed in connection with the despatching service.

Commenting upon this situation the New York *Sun,* usually well informed and conservative, says:

**"The plan will send a shiver through the frame of every old-time train despatcher in the land. They will recall instances when, owing to some temporary and unavoidable interruption of the telegraph circuit, they dared to trust to the accuracy of the 'phone' in conveying instructions to a belated train at some point on the road—a risk never ventured on except in case of absolute necessity.**

**"By the telegraphic system every word and every figure is spelled out, letter by letter, on the machine, and is written down by the receiving operator who afterward repeats the order, letter by letter and word by word, to the despatcher, for the purpose of comparison and affirmation. By this means, misunderstanding, on the part of the receiving operator, of a single word is immediately detected and rectified; and no train order is valid until it bears the despatcher's 'O. K.'**

**"Undoubtedly, some such method of verification will be followed under the new system; but the question is, will the telephone be as trustworthy as its predecessor? The telephone has lately attained a high degree of perfection; but the fact remains, nevertheless, that it frequently misrepresents, or rather seems to misrepresent, the sound of the voice. While such a defect may be trivial at ordinary times, its existence might prove incalculably disastrous where the safety of hundreds of human lives depends upon absolute accuracy of transmission."**

In this case the *Sun* has spoken without due consideration or information. It is just as easy to verify a despatch order, word by word and figure by figure, and receive the despatcher's "O. K." completing the order, over the telephone as it is over the telegraph line. The main point is that it is far quicker. Anybody who can hear and write can receive a train order sent by telephone. The experience of the Erie Railroad, as pointed out in the ELECTRICAL REVIEW by Mr. F. L. Blendinger, superintendent of telegraphs of that system, has been entirely satisfactory and there is little doubt that the despatch work of the Lackawanna system will not only be facilitated and reduced in cost but actually made better by the new system. It must be considered that the ordinary country station operator is by no means the most proficient of his class. Orders as sent out ordinarily from a despatching office are of the briefest kind, more or less filled with figures and abbreviations. There seems as much chance for a mistake in the telegraphic reception of these from the sounder as there is in getting them over the telephone. As far as the telephone misrepresenting or seeming to misrepresent the sound of the voice, the *Sun* must have derived its experience of telephones from instruments not working under the best conditions. With a good, well-built and well-cared-for line and modern telephones, conversation over such distances as will be encountered on the Lackawanna Railroad service will be practically as easy as talking through a hole in the wall.

The train despatching service of the Albany & Hudson Railroad, which is described at length on other pages of this issue, is operated by both telephone and telegraph. That is, the despatcher has both these means at his command; but he generally uses the telephone because it is much quicker. The average time taken to complete an order consisting of twenty or thirty words, with train numbers, times, etc., is under two minutes.

### *SOME CHAPTERS IN ELECTROCHEMISTRY.*

In this issue of the ELECTRICAL REVIEW is given the first article of the series under the general title "Selected Chapters in Electrochemistry," by Professor H. C. Jones, of the Johns Hopkins University. The subject dealt with is that which underlies the modern conceptions of electrolytic action, the phenomena of osmotic pressure.

There is no more singular illustration of the catholicity of science than that researches undertaken by a botanist, with a view to determining something of the nature of an action manifested in the cells of plants, should turn out to be the fundamental base upon which is built the new science of electrochemistry. Nothing, indeed, seems further from connection with an electrical subject than osmotic pressure and the curious action of liquids mingling through a porous partition. It remained for that remarkable genius Van't Hoff to observe the bearing of the deduction of experimenters on osmosis upon electrical action.

This first chapter is a necessary introduction to the valuable papers which will follow it. The second chapter of the series will deal with the theory of electrolytic dissociation.

## THE THEORY OF ALTERNATING DYNAMO ELECTRIC MECHANISMS—XXXV.

BY W. ELWELL GOLDSBOROUGH.

The complete vector diagram of Fig. 99 represents the phase relations which will exist in the whole system when the alternator $E^I$ is alone active. If alternator $E^I$ is made inoperative and alternator $E^{III}$ is caused to develop an electro-motive force, a similar solution to that already given will result in developing the phase relations which exist in a system consisting of the parallel circuits $A_1O$ and $A_2O$ connected in series with the circuit $OA_1$. If, further, it is desired to ascertain what electro-motive force developed by alternator E will maintain at the terminals of the parallel circuits an electro-motive force $OA_3^{III}$ of Fig. 100 equal to the electro-motive force $OA_1^I$ of Fig. 99, a phase diagram must be constructed by following the process already outlined. By this we find that an electro-motive force $OA_3^{III} = E_1^{III}$ will set up a current $I_1^{III} = OB_1^{III}$ in the circuit $A_1O$, and the current $I_2^{III} = OB_2^{III}$ in the circuit $A_2O$. The resultant of these branch currents will be the main-line current $OB_3^{III}$, which must be forced through the circuit $OA_3$. The construction of Fig. 100 shows that to force the current $OB_3^{III}$ through the circuit $OA_3$ will require an electro-motive force $A_3^{III}A^{III}$; and that, finally, the generator $E^{III}$ must develop an electro-motive force equal to $OA^{III}$ in order to maintain the conditions imposed.

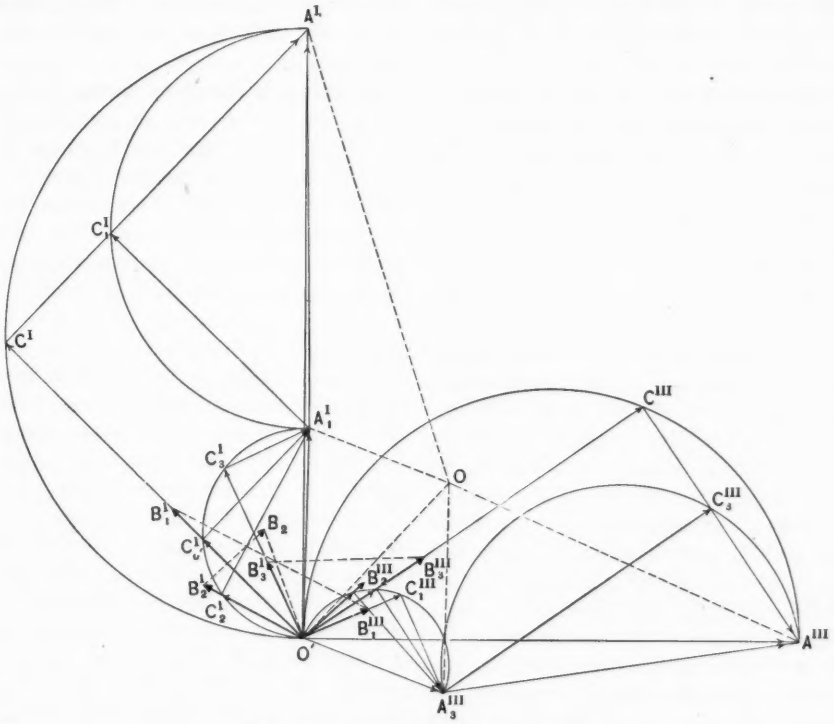



FIG. 101.—ALTERNATING MECHANISMS.

Now, what results when both the alternators are active can only be determined by combining the phase diagrams of Figs. 99 and 100. Suppose, for instance, that, when operating synchronously, the alternator $E^{III}$ develops an electro-motive force that is 90 degrees in advance of the electro-motive force developed by the alternator $E^I$. The electro-motive forces of the machines will then appear in the phase positions of the vectors $O'A^{III}$ and $O'A^I$ of Fig. 101. Further, we will assume that alternator $E^I$ develops an electro-motive force equal in magnitude to $O'A^I$ and that alternator $E^{III}$ develops an electro-motive force equal to $O'A^{III}$. Now, upon these vectors must be built up, by a process of proportional adjustment, phase diagrams like those shown in Figs. 99 and 100. In accomplishing this, each dimension of Fig. 99 must be changed in the ratio of the vector $O'A^I$ of Fig. 101 to the vector $OA^I$ of Fig. 99, and given its proper phase position relatively to $OA^I$ of Fig. 101.

By this process it will be found that, when the alternator $E^I$, acting alone, develops an electro-motive force equal to $O'A^I$ of Fig. 101, a current equal to $O'B_1^I$ will flow in its armature, while currents equal respectively to $O'B_2^I$ and $O'B_3^I$ will flow in the circuits $A_2O$ and $A_3O$.

In providing for the phase diagram which must be built up on vector $O'A^{III}$ of Fig. 101, each dimension of Fig. 100 must be altered in the ratio of the vector $O'A^{III}$ of Fig. 101 to the vector $OA^{III}$ of Fig 100. If the vectors so changed are given the same phase position in Fig 101 relatively to $O'A^{III}$ that they have in Fig. 100 relative to $OA^{III}$, the phase diagram represented by $O'C^{III}A^{III}$ of Fig. 101 will result, which shows that when the alternator $E^{III}$ is acting alone and developing an electro-motive force equal to $O'A^{III}$, Fig. 101, a current equal to $O'B_3^{III}$ will flow in its armature, and currents equal to $O'B_1^{III}$ and $O'B_2^{III}$ respectively will flow in circuits $A_1O$ and $A_2O$.

When both alternators are operating and developing respectively the electro-motive forces equal to $O'A^I$ and $O'A^{III}$, resultant currents will flow in the system shown in Fig. 98, which are equal to the vectorial summation of the currents flowing in the several circuits, as represented by the current vectors of Fig. 101. For instance, electro-motive force $E^I$ acting alone sets up a current equal to $O'B_1^I$ in the circuit $A_1O$, and electro-motive force $E^{III}$ acting alone sets up a current equal to $O'B_1^{III}$ in the circuit $A_1O$. Now, since a positive current in the armature of one of the alternators, as indicated by the arrow heads in Fig. 98, is negative with reference to the armature of the other alternator in obtaining the resultant current which flows in the armature of alternator $E^I$, we must take the vectorial difference of the vectors $O'B_1^I$ and $O'B_1^{III}$, or the resulting current is equal to the vector distance $B_1^IB_1^{III}$. For the same reason, in obtaining the resultant current which will flow in the armature of alternator $E^{III}$, we must take the difference of the vectors $O'B_3^I$ and $O'B_3^{III}$, which is the vector distance, $B_3^IB_3^{III}$. Again, as also indicated by the arrows of Fig. 98, a positive current in the armature of alternator $E^I$ is a positive current in the circuit $OA_2$ and, likewise, a positive current in the armature of alternator $E^{III}$ is a positive current in the circuit $AO_3$; therefore, the resultant current which flows in the circuit $AO_3$ when both alternators are operating is found by taking the vector sum of the vectors $O'B_2^I$ and $O'B_2^{III}$. This results in giving us the vector $O'B_2$ equal to the resultant current in the circuit AO. So much for the currents.

When we determine the electro-motive forces which will appear between the common point O of the three circuits and the terminals $A_1$, $A_2$ and $A_3$, Fig. 98, a similar method of vector summation must be followed. The electro-motive force which alternator $E^I$ brings into being at the terminals of the circuit $A_1O$ is represented by the vector $A_1^IA^I$. The electro-motive force which alternator $E^{III}$ brings into being at the terminals of the same circuit is represented by the vector $O'A_3^{III}$; consequently, the electro-motive

force which will appear between the points $A_1$ and O is equal to the vectorial difference of $A_1^I A^I$ and $O'A_3^{III}$, or to the dotted vector $OA^I$, since $A_1^I O$ is drawn from $A_1^I$ parallel and equal to $O'A_3^{III}$. In like manner alternator $E^I$ impresses an electro-motive force equal to $O'A_1^I$ upon the circuit $A_3O$, while alternator $E^{III}$ impresses an electro-motive force equal to $A_3^{III}A^{III}$ upon this circuit. The vectorial difference of these electro-motive forces is equal to $OA^{III}$, since $A_3^{III}O$ is drawn from $A_3^{III}$ equal and parallel to $O'A_1^I$.

In the case of the middle circuit $A_2O$, the electro-motive force which the generators, acting separately, impress upon its terminals must be added. Taking the vector sum of $O'A_1^I$ and $O'A_3^{III}$, therefore, we get the dotted vector O'O, since, as already stated, $A_1^I O$ is drawn from $A_1^I$ parallel to $O'A_3^{III}$. We, therefore, find that the electro-motive forces which appear at the terminals of the three circuits have a common junction point O. This must, of necessity, be the case in order that the phase diagram shall be continuous. This is an interesting fact, and one that enables us to show in a very clear and convenient way the final phase relations which exist in the system.

# Science Brevities

**Frequency Indicator**—In a German physical paper Herr R. Kempf-Hartmann describes a simple workshop form of frequency indicator. A number of steel reeds are employed, these being weighted so that their vibration periods differ about one per second. They are actuated by an electromagnet excited by the current to be measured, and the amplitude of vibration of that one corresponding with the frequency is said to attain as much as one inch. As a general thing the reeds on either side also respond, and by examining the amplitude of vibration frequency can be estimated as closely as one-tenth of a period. By simple connections, which suggest themselves, the instrument can be made to sound an alarm if the frequency becomes abnormal.

**Aluminum Rectifiers**—Considerable interest has been elicited by experiments upon the curious action of aluminum cells, which have the property of allowing current to pass in one direction and shutting it off when it is attempted to pass it through in the other. In a recent communication to the French Academy, M. C. Pollak states that he has made aluminum rectifiers available for 200 volts. He employs a slightly acid solution of potassium phosphate as the electrolyte. The aluminum plates are soaked for some time in caustic alkali to do away with impurities, and a crust forms on them consisting of oxides and other aluminum compounds. This crust, he believes, is necessary for their proper action. When exposed to the air the crust remains unaltered, but when wet it gradually disintegrates so that when the cell is not in action the plates should be taken out and dried. If the temperature of the cells is permitted to exceed 40 degrees centigrade they allow a considerable portion of current to pass both ways. The life of a plate is from 500 to 800 hours. Several cells should not be employed in series unless they can be made precisely equal to each other.

**The Speaking Arc**—In the *Elektrotechnische Zeitschrift* Herr W. Peukert describes some further discoveries he has made in connection with the speaking arc. Without the use either of a telephone or a microphone it is stated that acoustic effects could be produced. A condenser of large capacity was mounted parallel with the arc and contained a key in its circuit. On depressing the key the arc gave a loud whistling noise when it had a certain definite length. This length could be varied within narrow limits, the pitch of the note varying accordingly. As soon as the arc length exceeded a certain definite maximum the whistling abruptly ceased but could be brought on again by reducing the length of the arc. Alternate charges and discharges of the condenser produce a periodic current of considerable maximum from the continuous current of six amperes. The electro-motive force at the arc was found to be not sensibly altered and remaining about 68 volts through the experiment. The frequency was about 10,000 cycles per second and the author points to the experiment as important, since it shows how strong alternating currents of high frequency and low voltage may be produced.

**Magnetic Analysis of Radium Rays**—M. H. Becquerel has improved his method of analyzing radium rays into their constituent forms of radiation. An *Electrician* abstract says: The active substance is placed in a uniform magnetic field. A thin, flat sheaf of rays parallel to the field is picked out, and the photographic impression of the rays, some of which are deflected by the field, is received on a sensitive plate normal to the field at nearly grazing incidence. The tracks left upon the plate are arcs of circles, which fuse together to form patches with circular outlines. A suitable disposition of successive screens with slits enables the observer to pick out any circular arc at pleasure. Two screens are necessary, since an infinite number of cylinders could be drawn through the linear source and a slit parallel to it. The undeflected rays are marked by straight tracks. They have the greatest penetrative power, and after traversing glass they traverse aluminum 0.1 millimetre thick without suffering any change, and evidently retaining their characteristic value of $mv/e$. They produce no secondary radium rays, such as are produced whenever the rays are absorbed. The secondary rays produce tertiary rays, and rays of higher orders. They proceed from both surfaces of the material they impinge upon.

**Physiological Effects of Radium Rays**—In an interesting note in the *Comptes Rendus,* MM. Becquerel and Curie give an account of various painful experiments which have been made in connection with the study of radium rays. The first martyr to science in this connection was Giesel, who placed a radium preparation in a celluloid case strapped to his arm for two hours. At first the skin showed only a slight reddening. About two or three weeks afterward inflammation set in. M. Curie was the next victim. He exposed his arm for 10 hours and on the twentieth day following had a very sore arm requiring a bandage. On the forty-second day the arm began to get well but even on the fifty-second day a discoloration showed where the surface had been affected. M. H. Becquerel placed a very active radium preparation in his waistcoat pocket for six hours. The resulting sore took 10 days to develop and 40 days to heal. Several others had similar experiences and all who have worked with very active preparations experience pains and sores in their fingers which take two months to recover.

**The Manufacture of Hydrogen**—Writing in a German chemical journal Herr O. Schmidt describes a commercial apparatus for the electrolysis on a large scale of a dilute solution of potassium carbonate. Iron electrodes in series are used and the gases issued by separate channels. Two and one-half volts per pair of electrodes are necessary and each kilowatt-hour produces 168 litres of hydrogen and half the same quantity of oxygen, the gases being within one or two per cent of purity. The hydrogen is compressed in strong cylinders for purposes of convenient handling and is stated to have found some use in connection with Welsbach mantles for lighting. It is stated that one normal candle-hour costs with acetylene 0.012 cent and with hydrogen and the mantle burner only 0.005 cent.

# Selected Chapters in Electrochemistry–I.

By Harry C. Jones.

## CHAPTER I—OSMOTIC PRESSURE.

### INTRODUCTION.

IT IS WELL KNOWN that in the last few years a new branch of science has come into existence. Since the phenomena with which it deals lie midway between physics and chemistry, it is called physical chemistry, and to distinguish it from the older physical chemistry, from which it differs fundamentally and in kind, it has been termed the new physical chemistry.

This subject embraces a number of chapters, such as the study of atoms and molecules, of solids, liquids, and gases, of thermochemistry, electrochemistry, chemical dynamics and statics, etc. That portion of physical chemistry which concerns us here has to do with the transformations of chemical energy into electrical, and of electric energy into chemical, and this constitutes the subject matter of electrochemistry.

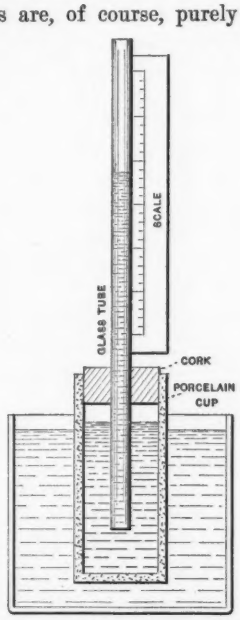
It is not the intention of these papers to treat the subject of electrochemistry in a systematic or exhaustive manner, as would be done in an advanced text-book on this subject, but to take up certain sections which seem particularly interesting and important.

It would be impossible to plunge intelligibly into the subject matter of electrochemistry without first studying some phenomena which lie at the foundation of all electrochemistry, and upon which it rests. We shall take up first the phenomena connected with osmotic pressure, and point out certain relations between the osmotic pressure exerted by solutions and other physical phenomena which are well known.

### WHAT IS MEANT BY OSMOTIC PRESSURE.

It was known from the earliest time that when certain solid substances are brought in contact with certain liquids, the former dissolve, and when quantitative methods began to be discovered it was soon found that such substances distributed themselves uniformly throughout the solvent. This phenomenon was called diffusion, but the cause of diffusion was entirely unknown. Why does the dissolved substance pass into every portion of the solvent until the whole solution becomes homogeneous, each equal volume containing the same amount of the dissolved substance? The question could not be answered. This was all the more perplexing when it was considered that substances much heavier than the solvent would rise from the bottom of the containing-vessel into the solvent, right against the pull of gravity. Another fact which had been known for a long time is that an animal bladder, when filled with a mixture of alcohol and water and plunged into pure water, will swell up and burst. It was obvious that there is some pressure manifesting itself in this case, and such has been termed *osmotic pressure.*

A pressure similar to the above was found to exist at the surface of contact of every solution with the pure solvent, and also at the surface of contact of every solution of a substance with every other solution of different concentration. These observations are, of course, purely qualitative, but, like the study of every phenomenon in science, we have first the qualitative observations and then the quantitative measurements. The earlier observers had no conception as to the magnitude of the osmotic pressure which a solution will exert, and no idea how it could be measured.




DETERMINATION OF OSMOTIC PRESSURE.

### THE MEASUREMENT OF OSMOTIC PRESSURE.

If we were dependent upon animal membranes or upon any other natural membrane to measure the magnitude of osmotic pressure, our knowledge of this subject would be most unsatisfactory. But artificial membranes, which can stand many times the pressure of any natural membrane, have been prepared and used successfully to measure the magnitude of the osmotic pressure exerted by not too concentrated solutions.

In order that any membrane may be used to measure osmotic pressure it must allow the pure solvent to pass through, but prevent the dissolved substance from passing. Thus, in the case of a solution of cane sugar in water, the membrane must allow the water to pass readily through, but must be impervious to the cane sugar molecules. The reason for this is obvious. If the membrane which separated the solutions of different concentrations allowed the dissolved substance to pass through, the solutions on the two sides would by diffusion become of the same concentration and no osmotic pressure would exist between them. Such membranes, which are permeable to the solvent but are impermeable to the dissolved substance, are known as *semi-permeable membranes.*

It has been found that certain precipitates have this property of allowing water to pass through them, but of preventing certain substances, like cane sugar. Among these should be mentioned copper ferrocyanides the precipitate formed when a solution of potassium ferrocyanide is brought in contact with a solution of a soluble copper salt, say copper sulphate. The reaction is expressed by the following equation:

$$K_4Fe(CN)_6 + 2CuSO_4 = Cu_2Fe(CN)_6 + 2K_2SO_4.$$

A number of other substances, such as calcium phosphate, Berlin blue, etc., have been found to have the same property to some extent.

In order that such a precipitate should be used to measure osmotic pressure it must be given a resistant support, and the following device has been adopted. The precipitate was deposited right in the walls of a fine-grained porcelain cup, by filling the cup with a solution of potassium ferrocyanide and immersing it in a solution of copper sulphate. Where the two solutions came together in the walls of the cup the precipitate was formed, and had the property of semi-permeability, which is essential to the measurement of osmotic pressure.

In preparing these membranes great care and patience are necessary to work out the details, but this is not the place to discuss these details.*

Having prepared the cell containing the semi-permeable membrane, it was filled with the solution whose osmotic pressure was to be measured, and tightly closed by

*See Pfeffer's monograph on Osmotische Untersuchungen, Leipzig, 1877.

means of a cork, through which a manometer passed. The cell containing the solution was then immersed in a vessel containing pure water. The water passed through the semi-permeable membrane into the cup, and produced a pressure which could be read on the manometer. Water would continue to flow in until the hydrostatic pressure on the inside was just equal to the osmotic pressure which the solution was capable of exerting against the pure solvent. By reading the maximum pressure produced, by means of the manometer, we have the osmotic pressure of the solution which is equal to it.

### RESULTS OF THE MEASUREMENT OF OSMOTIC PRESSURE.

The first fact which was noticed as the result of the quantitative study of osmotic pressure, was the enormous magnitude of the pressure which even dilute solutions can exert. From the earlier observations on osmotic pressure, by means of which an animal bladder was burst when it was filled with a fairly concentrated solution of alcohol, the conclusion was drawn that in osmotic pressure we have to deal with an appreciable force; but no one imagined for a moment that the magnitude of the force was as great as it is. Pfeffer, who is now Professor of botany in the University of Leipzig, found that a tenth-normal* solution of cane sugar in water has an osmotic pressure of about two atmospheres. If an open water manometer was used, the column of water would rise to a height of more than 66 feet.

Pfeffer studied the osmotic pressures of solutions of a number of substances at different concentrations, and a few of his results are given below to illustrate certain relations which will be pointed out a little later:

CANE SUGAR.

| Concentration in Per Cent by Weight. | Osmotic Pressure. |
|---|---|
| 1 | 535 mm. |
| 2 | 1,016 " |
| 4 | 2,082 " |
| 6 | 3,075 " |

Pfeffer also studied the effect of temperature on the osmotic pressure of a solution of cane sugar. He used a one per cent solution, and measured its osmotic pressure at different temperatures. He obtained the following results:

| Temperature. | Osmotic Pressure. |
|---|---|
| 14°.2 C | 510 mm. |
| 32°.0 C | 544 " |
| 6°.8 C | 505 " |
| 13°.7 C | 525 " |
| 22°.0 C | 548 " |
| 15°.5 C | 520 " |
| 36°.0 C | 567 " |

*A normal solution of cane sugar is one which contains a gram-molecular weight — 342.1 grams, in a litre.

Pfeffer was studying osmotic pressure from the standpoint of a botanist, and the remainder of his work has to do chiefly with the botanical significance of his measurements. He did not point out any relations between the osmotic pressure of solutions and the gas-pressure of gases. This remained for another.

### RELATIONS BETWEEN OSMOTIC PRESSURE AND GAS-PRESSURE.

That there was any relation between the osmotic pressure of a solution and the gas-pressure of a gas was not suspected until the epoch-making paper* of the great Dutch Physical Chemist, Van't Hoff, appeared in 1887. This paper bears the title "The Role of Osmotic Pressure in the Analogy between Solutions and Gases," and the title is self-explanatory.

Van't Hoff's† attention was called to the experimental work of Pfeffer by his colleague in the University of Amsterdam—the botanist De Vries—and he took up a study of Pfeffer's results in connection with certain other problems in which he was interested at that time.‡ He was at once impressed by the relation between the osmotic pressures of solutions and their concentrations. The osmotic pressure increases with the concentration of the solution, and the important point is that the osmotic pressure increases proportional to the concentration. This can be seen at once if we divide the osmotic pressures of the different solutions by the percentage concentrations of the solutions, as Van't Hoff did. The following results will illustrate the point. If we represent the concentrations by C, and the osmotic pressures by P; P divided by C is a constant:

| C | P | $\frac{P}{C}$ |
|---|---|---|
| 1% | 535 mm. | 535 |
| 2% | 1,016 " | 508 |
| 4% | 2,082 " | 521 |
| 6% | 3,075 " | 513 |

The value of $\frac{P}{C}$ is as nearly constant as could be expected when we consider the difficulties and large experimental errors which are necessarily involved in all measurements of osmotic pressure.

Of what scientific value was the discovery of this relation? Would it not, after all, be just what we should expect? If one molecule exerts a given osmotic pressure, would not two molecules exert twice this pressure, three molecules three times the pressure and *n* molecules *n* times the pressure? This is just what is expressed by the above relation; but to a mind of the type of that of Van't Hoff it meant a great deal more. He saw in this relation an analogy to the *Law of Boyle for Gases.* This law says that the pressure exerted by a gas is proportional to the concentration of the gas.

It seemed, then, from these few results that *the Law of Boyle for Gas-Pressure Applied to the Osmotic Pressure of Solution,* and that the two kinds of pressure were analogous, at least in this one respect, that they were proportional on the one hand to the concentration of the solution, on the other to the concentration of the gas.

Having found that the law of Boyle for gas-pressure applies to the osmotic pressure of solutions, Van't Hoff naturally began to look around for other analogies between the two kinds of pressure. We have seen that the osmotic pressure of a solution increases with increase in temperature, and it is well known that the gas-pressure of a gas increases with increase in temperature. Does any relation exist between the amount by which the osmotic pressure is increased, and the amount by which gas-pressure is increased? This would be tested by studying the pressure of a gas at a given temperature and then at a somewhat higher temperature, and observing the increase in pressure for a given increase in temperature. This, as is well known, has been very carefully done, and the results have led to the generalization known as the law of Gay Lussac, which says that the pressure of a gas increases a constant amount for every increase in temperature of one degree; and the increase in pressure amounts to one-two hundred and seventy-third of the original pressure of the gas at zero Centigrade. To test this law for osmotic pressure we should naturally proceed as follows: The osmotic pressure of a solution would be measured at a given temperature, and then measured again at a somewhat higher temperature, and the difference between the two pressures noted. The difference between the two temperatures would also be noted, and from these data we could calculate at once the increase in osmotic pressure for a rise in temperature of one degree.

This is exactly what has been done by Pfeffer, as will be seen by examining the second set of his results, given in an earlier part of this paper. If we divide the difference between the osmotic pressures at any two temperatures by the difference in temperatures we shall find that the value is not exactly the same for different experiments, and is not one-two

*Ztschr. phys. Chem.* 1, 481. English by H. C. Jones, in *Harper's Science Series,* vol. IV, p. 13.

†For further detail see Theory of Electrolytic Dissociation by H. C. Jones (Macmillan's.)

‡Van't Hoff was at that time Professor of chemistry in Amsterdam. He is now Professor of Physical Chemistry in the University of Berlin.

hundred and seventy-third of the original osmotic pressure. This might at first be interpreted to mean that the law of Gay Lussac does not apply to the osmotic pressure of solutions, but we must again consider the enormous difficulties involved in making good semi-permeable membranes, and in carrying out osmotic pressure determinations with even a fair degree of accuracy. Taking all of these matters into account, and, further, that the temperature coefficient of osmotic pressure found from the results of Pfeffer always approached the value one-two hundred and seventy-third, Van't Hoff concluded that it was probable that the law of Gay Lussac for the temperature coefficient of gas-pressure applied to the osmotic pressure of solutions.

Van't Hoff, however, made use of another principle in testing the law of Gay Lussac, as applied to the osmotic pressure of solutions. If a gas were placed in a closed glass tube and the two ends of the tube kept at different temperatures, the gas would distribute itself throughout the tube, so that the pressure would be the same at every point. In the warmer portion of the tube a gas molecule would exert a greater pressure than in the cooler portion, and, consequently, the gas would become more dilute in the warmer portion and more concentrated in the cooler portion of the tube. The difference in concentration could be calculated from the law of Gay Lussac, knowing the difference between the temperatures of the two ends of the tube.

If a tube is filled with a homogeneous solution and one end kept at a higher temperature than the other, the solution will become more dilute in the region where the temperature is higher. This is known as *the principle of Soret.* If the law of Gay Lussac applies to the temperature coefficient of the osmotic pressure of solutions, we could calculate the difference in concentration between the warmer and colder portions of the tube, knowing the difference in the temperatures, just as we can calculate the difference in the concentrations of a gas, as described above.

The experiments were carried out by filling glass tubes with a homogeneous solution, and keeping the tops of the tubes at a higher constant temperature than the bottoms. After the tubes had stood for what was supposed to be a sufficient length of time, a measured volume of the solution was removed from the top and analyzed, and a measured volume removed from the bottom and also analyzed. Knowing the concentration of the original homogeneous solution, and the difference between the concentrations at the top and bottom of the tube, we have all the data necessary for testing the principle of Soret, as applied to solutions.

The results at first showed smaller differences in concentration for a given difference in temperature than would be expected if the law of Gay Lussac applied to the temperature coefficient of the osmotic pressure of solutions. It then occurred to Soret and others that perhaps the solution had not been allowed to stand long enough at the different, constant, temperatures, in order that equilibrium should be reached. It is well known that the time required for equilibrium to be established by diffusion alone is very great, and, of course, all mechanical disturbance of the liquid must be avoided in these experiments. The experiments were then repeated, allowing the tubes to remain undisturbed for a much longer time. The result was that a larger difference was found between the concentrations of the warmer and colder solutions, for a given difference in temperature, than in the first series of experiments. Results were finally obtained which are very satisfactory, as the following examples will show:

The two portions of a solution of copper sulphate were kept at 20 degrees and 80 degrees, respectively. The change in concentration calculated from the law of Gay Lussac is 14.3 per cent; the difference in concentration found is 14.03 per cent. In another case, where the difference calculated was 24.8 per cent, the difference found was 23.87 per cent.

If the tubes had been allowed to remain still longer it seems probable that the values found would have agreed even more closely with those calculated. The difference is, however, so small that the conclusion is justified that the *law of Gay Lussac for gas-pressure applies to the osmotic pressure of solutions.*

The applicability of the two laws of gas-pressure thus far considered to the osmotic pressure of solutions simply shows that the two sets of phenomena are analogous, but tells us nothing as to the actual magnitude of the two pressures, or as to the relations between these magnitudes. We must now take another step and ascertain, if possible, what relation exists between the actual pressure exerted by a gas of given concentration and at a given temperature, and the osmotic pressure of a solution containing the same number of dissolved parts in a given volume as there are gas particles in the same volume; the osmotic pressure being, of course, measured at the same temperature as the gas-pressure.

Van't Hoff compared the gas-pressure of hydrogen gas with the osmotic pressure of a solution of cane sugar of the same concentration as the gas; *i. e.*, having the same number of sugar molecules in a given volume of the solution as there are hydrogen molecules in the same volume of the gas. The result, which is very surprising, is that *the solution exerted an osmotic pressure which was exactly equal to the gas-pressure exerted by the gas, and since the law of Avogadro applies to gases, it must, therefore, apply to solutions.*

The law of Avogadro, as applied to gases, states that equal volumes of all gases at the same temperature and pressure contain the same number of ultimate parts. As applied to solutions it would be formulated thus; equal volumes of all solutions, which, at the same temperature, have the same osmotic pressure, contain the same number of ultimate parts.

We have thus far seen that the three fundamental laws of gas-pressure apply to the osmotic pressure of solutions;* but we know that there are conditions under which these laws do not hold for the pressures exerted by gases. If the gases are very concentrated neither the law of Boyle nor that of Gay Lussac will apply to its pressure. The relations between gas-pressure and osmotic pressure are all the more striking, in that for the same conditions under which the laws do not apply to gases, they do not apply to the osmotic pressure of solutions. Although it is impossible to measure directly the osmotic pressure of concentrated solutions, there are a number of indirect methods of doing so; and from the results obtained by these indirect methods it is quite certain that neither the law of Boyle nor that of Gay Lussac applies to the osmotic pressure of concentrated solutions.

The relations between gas-pressure and osmotic pressure are certainly made very striking by the fact that the three fundamental laws of gas-pressure apply to the osmotic pressure of solutions, but these relations are certainly made much closer, and become more interesting when we learn that under exactly the same conditions which present exceptions to the laws of gas-pressure, we have exceptions manifesting themselves in the same sense, when we attempt to apply these laws to osmotic pressure.

SIGNIFICANCE OF THE ABOVE RELATIONS.

The full significance of the above relations between gas-pressure and osmotic pressure could be appreciated only by one who has a comprehensive knowledge of the

* For a fuller discussion of this subject, with thermodynamic demonstrations, see Van't Hoff's original paper (*Loc. cit.*) or Theory of Electrolytic Dissociation—Jones.

whole subject of modern Physical Chemistry. The importance of these relations in certain directions is, however, so obvious that it can not fail to be recognized.

The fact that the osmotic pressure of solutions obeys the gas laws makes it possible to deal with solutions in many respects as we deal with gases. Before these relations were known the whole subject of solutions seemed to be of secondary interest and importance. It was recognized, to be sure, that most chemical reactions take place in solution, but there was no efficient means of dealing with solutions as such. Any one who is at all familiar with the principles of physics knows full well that matter in the gaseous state lends itself to our methods of investigation, and especially to mathematical methods, better than in any other form of aggregation. We can readily apply thermodynamics to gases, and it may be said in general that we know far more about matter in the condition of a gas than in the condition of a liquid; and, in turn, far more about the liquid condition than about the solid. Indeed, our knowledge of matter in the solid state, other than its external form, is, after all, very superficial and most unsatisfactory.

Since we can deal with gases mathematically, and since the laws of gas-pressure apply to the osmotic pressure of solutions, we can apply mathematics to solutions in a manner analogous to that which has been used with gases. The result is that the very greatest advances have been made in the study of solutions since the relations described in this paper were pointed out by Van't Hoff in 1887. Since we can deal with solutions by entirely new methods, and since solutions lie at the basis of most chemical phenomena, we have new methods opened up for dealing with these phenomena.

The importance of these relations for the subject in hand can not easily be overestimated, as we shall probably see before this series of papers is concluded. Their influence is felt throughout a large portion of the field of electrochemistry, and some of the most important developments in electrochemistry in the last 15 years have been based directly upon them. To take one example, the action of the primary cell. This was not understood and not satisfactorily explained until these relations were discovered. It was not even known where the chief source of the electro-motive force was. We can now explain the action of the primary cell in a satisfactory manner, and can go even farther and calculate the electro-motive force; into this calculation, as we shall see, the osmotic pressures of the solutions around the electrodes entering and playing a prominent rôle. In the modern developments in electrochemistry, this wide-reaching generalization connecting osmotic pressure and gas-pressure is not the only factor. Another generalization of even greater importance is involved and to this we shall turn in the next chapter.

### The Reduction and Refining of Copper by Electrolysis.

Ever since the invention of the dynamo electricians have endeavored to perfect methods of obtaining copper through the action of an electric current upon chemical solutions of pulverized ores, or of the concentrates produced by smelting or precipitation, says Consul-General C. B. Hurst, writing from Vienna. Millions have been spent in such experiments, and the result is as yet so equivocal and indefinite that only an expert versed in the whole science of electrometallurgy can discuss the subject intelligently. In Germany the principal workers in this field have been Messrs. Siemens & Halske, the eminent electrical manufacturers of Berlin, and Dr. Carl Hoepfner, who, about 1890, invented a process for precipitating copper and other metals from chloride solutions upon metallic disks (cathodes) forming part of an electric current and revolving in a bath of such solution.

The process of Messrs. Siemens & Halske dates from September, 1886, and it was applied in an establishment in Genoa about 10 years ago, for the purpose of refining a matte containing 30 per cent copper, 30 per cent sulphur and 40 per cent iron. After some months' operation, the plant was shut down, and subsequently, after certain technical difficulties had been overcome, was again started up, but with what success it is impossible to ascertain. A similar plant was erected at Stollberg, near Aix la Chapelle, but was discontinued in 1894. In June, 1890, Messrs. Siemens & Halske finished and put in operation a large plant for electrical refining of copper at their works in Martinkenfelde, near Berlin, but after a few months it was shut down or turned to the refining of other metals. The same firm has erected electrolytic copper-refining plants at Oker and at Goslar in the Harz Mountains copper districts, which seem to have been more successful, since Fisher, in his "Technology" of 1900, says of the plant at Oker that with six machines, each working with a current generated by seven to eight horsepower, there is obtained a product of 500 tons of copper per annum. At Goslar, where the process of Siemens & Halske is practiced in its most modern and improved form, the daily cost of operation, including wages, cost of current, interest on value of material, wear and tear of plant, etc., for refining one ton of copper per day, is put at 74.90 marks ($17.82) when working with a current of 30 amperes, and 58.95 marks ($14.02) when the energy is increased to 100 amperes.

The Hoepfner process for obtaining copper and other metals directly from the ore or concentrate by electrolysis was first described in 1891. Several plants have been erected to put it in operation, all of which have been more or less unsuccessful when applied to copper. The latest of these was built at Papenberg in 1898, but no authentic account of its industrial success can be obtained. The same process was tried in America with copper-nickel matte from Sudbury, Canada, but resulted in failure for the reason that the metals produced were spongy and below the merchantable standard of purity.

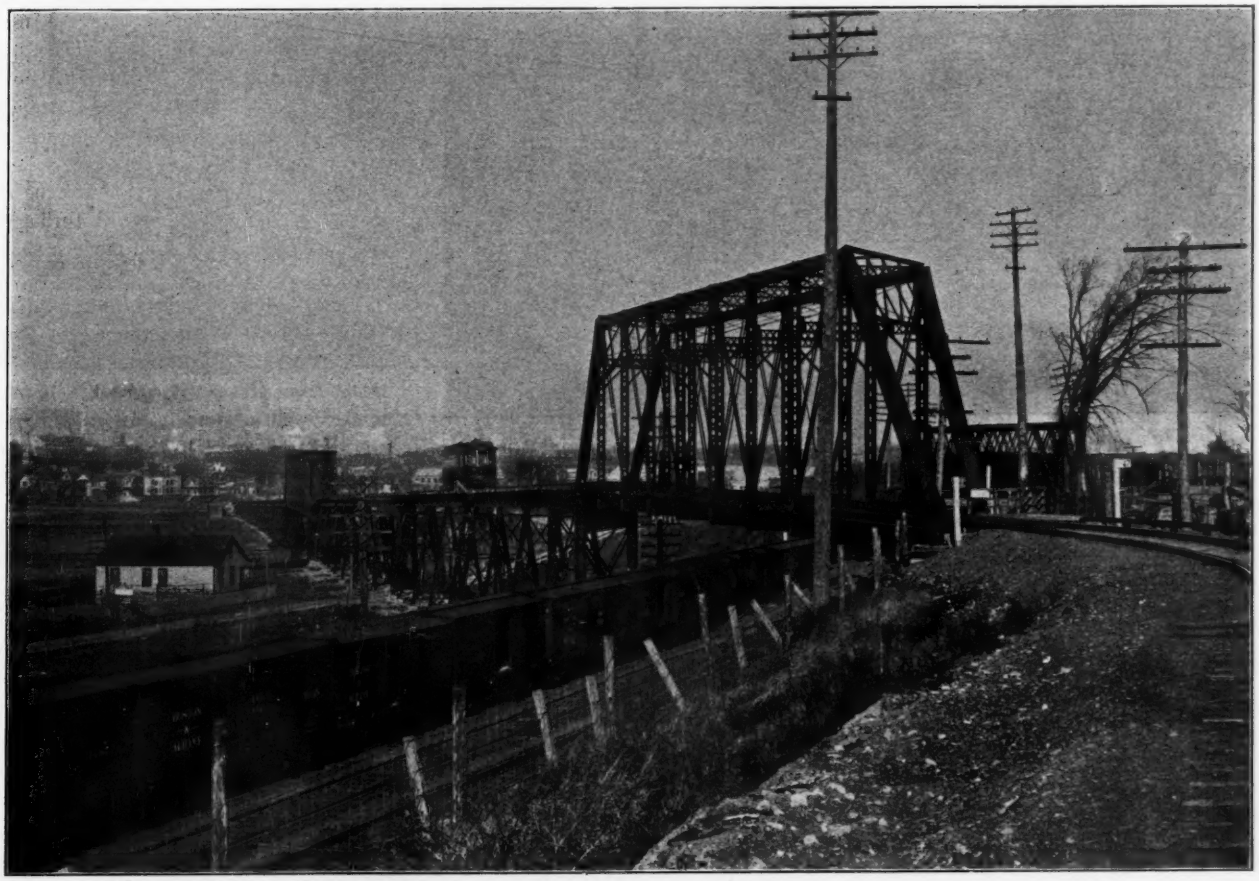
Under this process copper ores or concentrates are pulverized and then dissolved in a chlorine solution, which is treated in tanks made of wood impregnated with asphalt and lined with sheet lead. The anodes are of carbon, the cathodes of sheet copper, and they are separated in the bath by a diaphragm of cloth. The solution being decomposed by the action of the electrical current, the copper is deposited in crystals of pure metal on the cathode, while the chlorine thereby released remains in the stream of solution directed against the anode, and by combining with the protochloride forms bichloride of copper. The solution thus charged is then withdrawn from the tank, heated, and used in leaching fresh ore to obtain the original solution. The leaching process is a cycle, in which the solution is pumped up and passes through the pulverized ore again and again without addition of chemicals, and it is claimed that in working Rio Tinto ores containing 3.37 per cent copper, 91 per cent of the copper can be leached out in four hours, while only three per cent of the iron pyrites in the ore is dissolved. The leaching process is quickened by agitating the mixture of ore and solvent either in revolving drums or in stationary tanks by the injection of currents of air. Professor Schnabel gives the efficiency of this process at 90 pounds of copper in 24 hours for each horse-power converted into electrical current and passed through the precipitating circuit, but he declines to indorse the process as practically useful when applied to the refining of copper.

From all that can be learned from textbooks or by inquiry through experts, Americans have very little to learn from Germany in respect to the electrolysis of copper. Whether it is due to the greater practical ingenuity of American mining engineers, or to the greater purity and richness of their ores, the refining of copper by electrolysis seems to have attained a more extensive and successful development there than in this country. The enormous demand for electrolytic copper is, however, a potent stimulant to producers, and many able metallurgists, backed by liberal capital, are still working at the problem.

# The Albany and Hudson Railroad.

**Some Operative Details of the Largest Third-Rail Electric Railway System in the World.**

NO MORE INTERESTING development of electrical engineering has been made in recent years than the equipment of the Albany & Hudson Railway and Power Company's railway line, extending between the cities of Albany and Hudson, in New York state, a total distance of 37.2 miles. While the equipment of this railway system has often been described, it may be worth while here, as an introduction to what follows, concerning its operation, to recount briefly the general plan and equipment of the lines.



THE VIADUCT AT RENSSELAER ON THE ALBANY AND HUDSON RAILROAD.

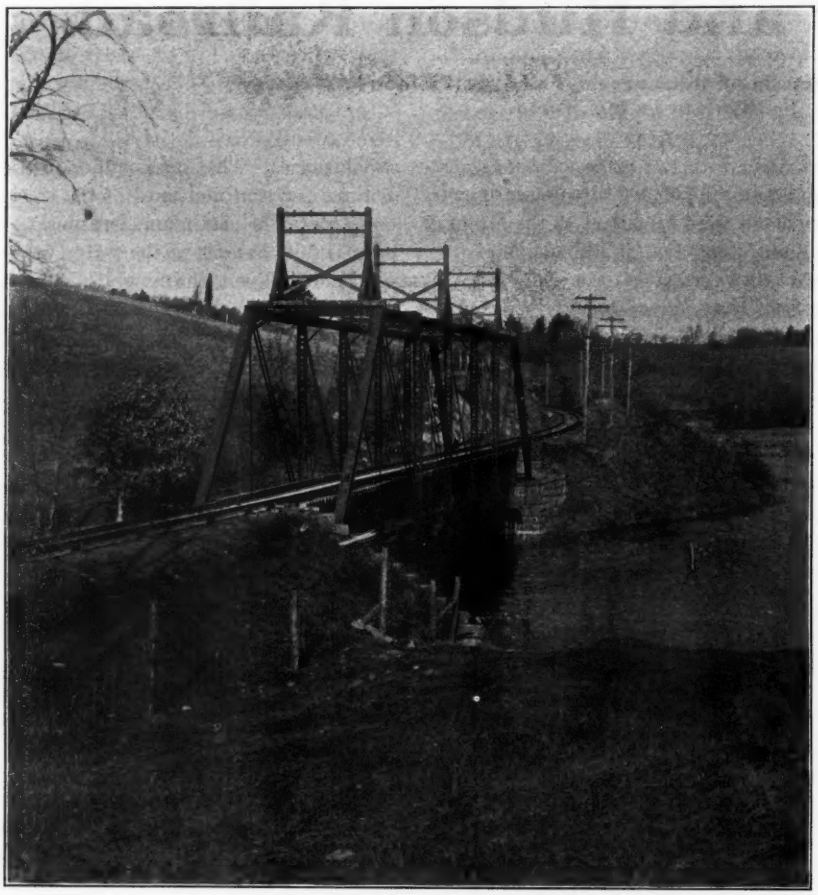
The railway line is of standard gauge, laid with 80-pound T rails, bonded with protected copper bonds placed under the fish-plates. At each joint there are two bonds with a double cross-sectional area of 844,000 circular mils. The cross bonding consists of flat iron tie-rods having eight-inch bonds at each end. The sidings are laid with 56-pound rails.

The third rail is also of 80-pound section, in 30-foot lengths, and is bonded at each joint with two protected bonds, having a total of 850,000 circular mils area. The bonds were furnished by the Mayer & Englund Company, of Philadelphia.

At road crossings the third rail is omitted, the sections being connected by means of lead-covered, paper-insulated cables of 1,000,000 circular mils section. In ordinary road crossings the gap in the third rail is 30 feet long and the car rides over this without necessitating that the current be cut off. On highway crossings the gap is longer and current is cut off, the car coasting over the interval. The third rail is insulated throughout its length upon blocks of creosoted wood, each provided with a malleable iron cap carrying keys which hold the flange of the rail. These are spaced about six feet apart on the ends of ties, the ties which carry the insulators being somewhat longer than the others in use.

The line runs through a number of thrifty villages, some of them being very old and exceedingly picturesque, as well as historic. The maximum gradient is three per cent and most of the track is on grade. The maximum elevation passed over is 500 feet above the water level of the Hudson River, the summit of the road being a little to the north of Kinderhook Lake. The region passed through by the road is one of the most beautiful in the country, having been celebrated in the writings of Washington Irving and others, and commanding beautiful views of the Hudson River, the Catskill Mountains and the Berkshire Hills.

At Stuyvesant Falls, which is situated 10.3 miles from Hudson, is located the power-house, which is of the combination type, employing both steam and water power. Water is taken from the Kinderhook Creek, a fall of 102 feet being available. The water is led 3,000 feet through a pair of steel penstocks, each seven feet six inches in diameter, laid side by side in a channel blasted for the purpose and terminating in two gigantic stand-pipes, each 104 feet in height, which



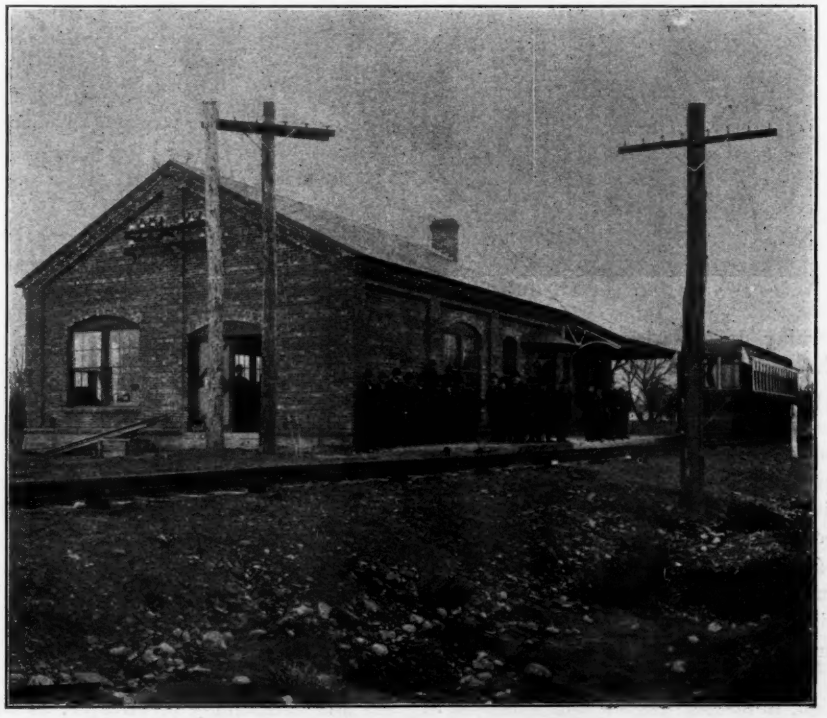
Bridge at Stockport on the Albany and Hudson Railroad.

are excellently shown in the accompanying illustrations. All of the steel work of these penstocks, etc., was furnished by the Riter & Conley Manufacturing Company, of Pittsburgh, Pa.

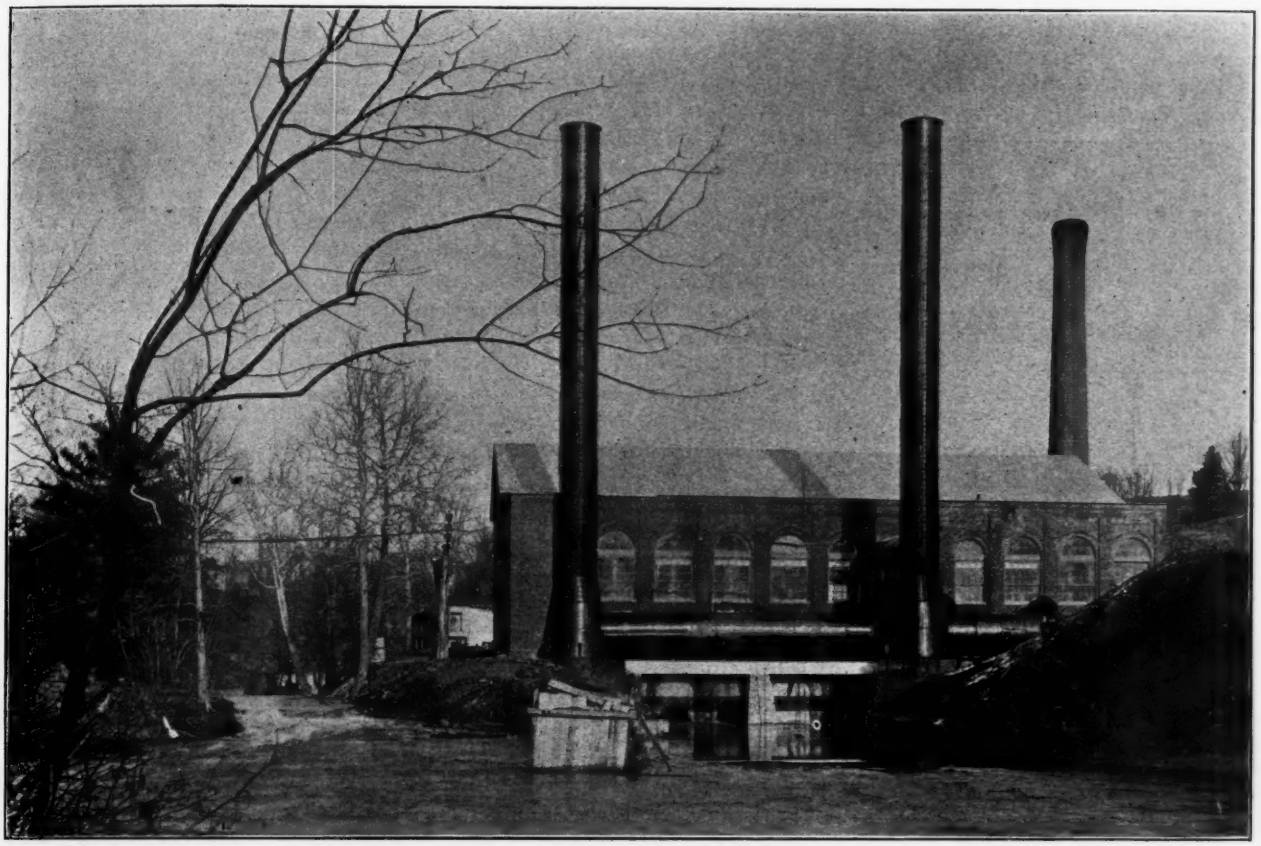
The power station itself is a brick building, 82 by 142 feet, and contains three types of dynamo machines, in addition to a complete auxiliary steam plant. For driving the railway there are installed three 750-kilowatt, 12,000-volt, 25-cycle, three-phase machines, which feed directly the transmission line going north and south from the station. Each of these machines is direct-coupled to a pair of 33-inch turbines, rated at 1,590 horse-power and running at a speed of 375 revolutions per minute. There are, in addition, two 200-kilowatt, 600-volt, direct-current generators, each direct-coupled to a single 30-inch, 435-horse-power turbine, running at 450 revolutions per minute and used to supply directly the near-by sections of the third rail. For lighting service there are two 250-kilowatt and one 125-kilowatt, single-phase, 2,200-volt, 60-cycle alternating machines, each of which is connected to an appropriate turbine, running at 600 revolutions per minute. For distant lighting service, as at Rensselaer and Hudson, 26 miles away, the current from these machines is stepped up by a battery of transformers to 12,000 volts, being appropriately stepped down again to 2,000 volts at Rensselaer and at Hudson for distribution. Appropriate exciters are installed for the lighting machines, these being also direct-coupled to water-wheels of their own. All of the electrical machinery was furnished by the General Electric Company, and all of the water-wheels by the Stillwell-Bierce & Smith-Vaile Company, of Dayton, Ohio. The water-wheels are all regulated by Lombard governors, obtaining their operating pressure from the penstocks themselves.

The switchboard in the power station is arranged in two galleries overhanging the water-wheels. In the lower gallery the generator, line and feeder panels are installed, these containing all of the instruments and operating levers. The high-tension wiring is entirely confined to the upper gallery, the switchboard attendant being out of all danger of contact with high-tension apparatus. The high-tension switches are of the oil type and the construction of the switchboard throughout is of the most careful and modern character.

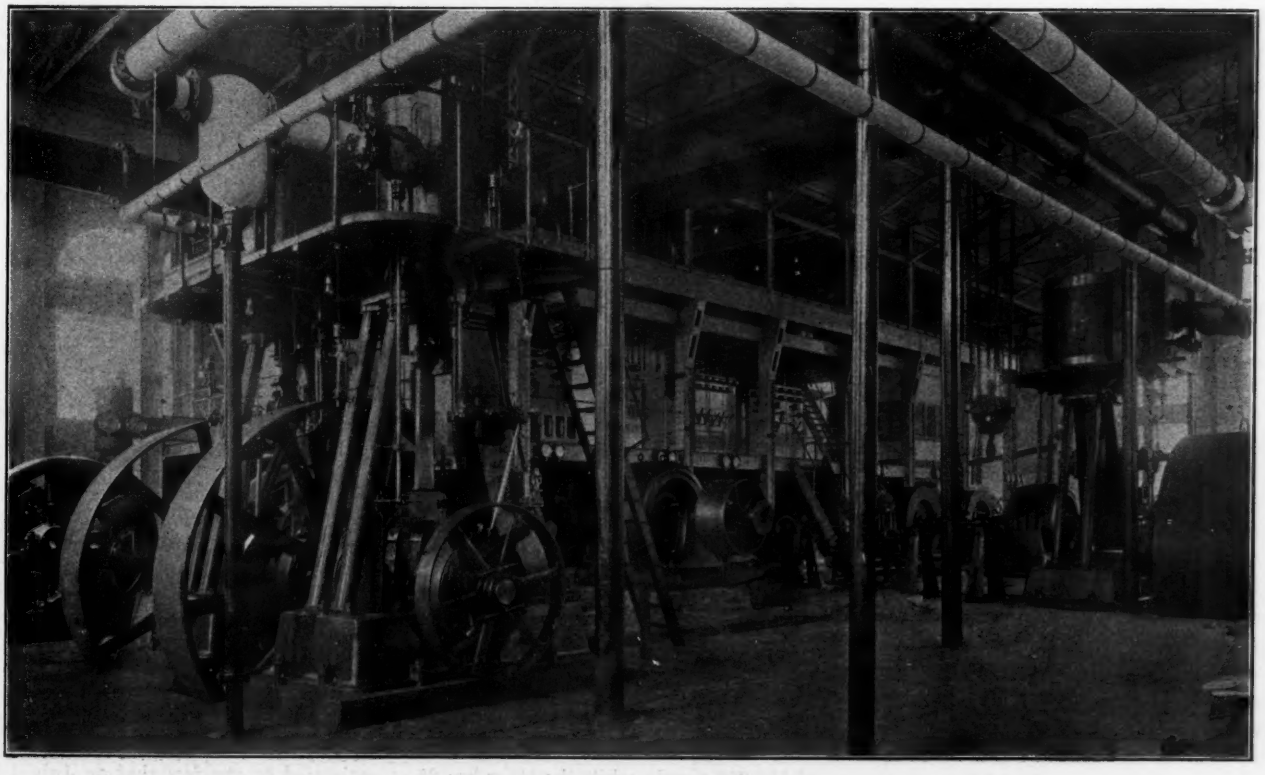
There are three substations, located at Hudson, North Chatham and East Greenbush, respectively 8, 11 and 23 miles distance from the power station. It is intended eventually to install a fourth substation at Rensselaer, near the northern extremity of the line. The heaviest wire on the transmission line is of No. 00 gauge, this running northward to the North Chatham station. In each of the



Car Barn and Substation, Upper Hudson.

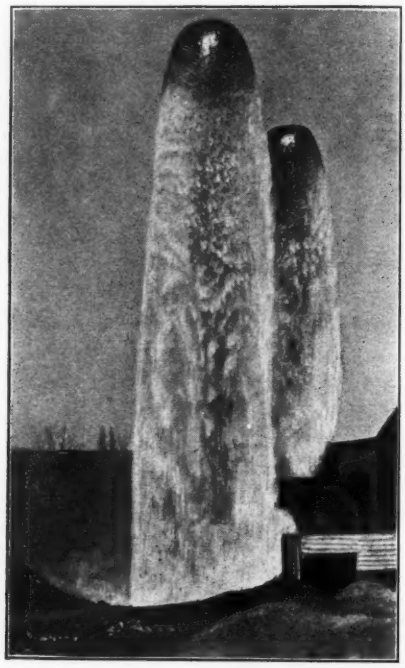


EXTERIOR OF THE ALBANY AND HUDSON RAILROAD AND POWER COMPANY'S POWER-HOUSE AT STUYVESANT FALLS, N. Y.



ONE OF THE ENGINE UNITS IN THE POWER-HOUSE.

Chatham and Greenbush substations there is installed one 200 and one 400-kilowatt rotary converter with the necessary switchboard and step-down transformers, these machines operating to deliver 600 volts



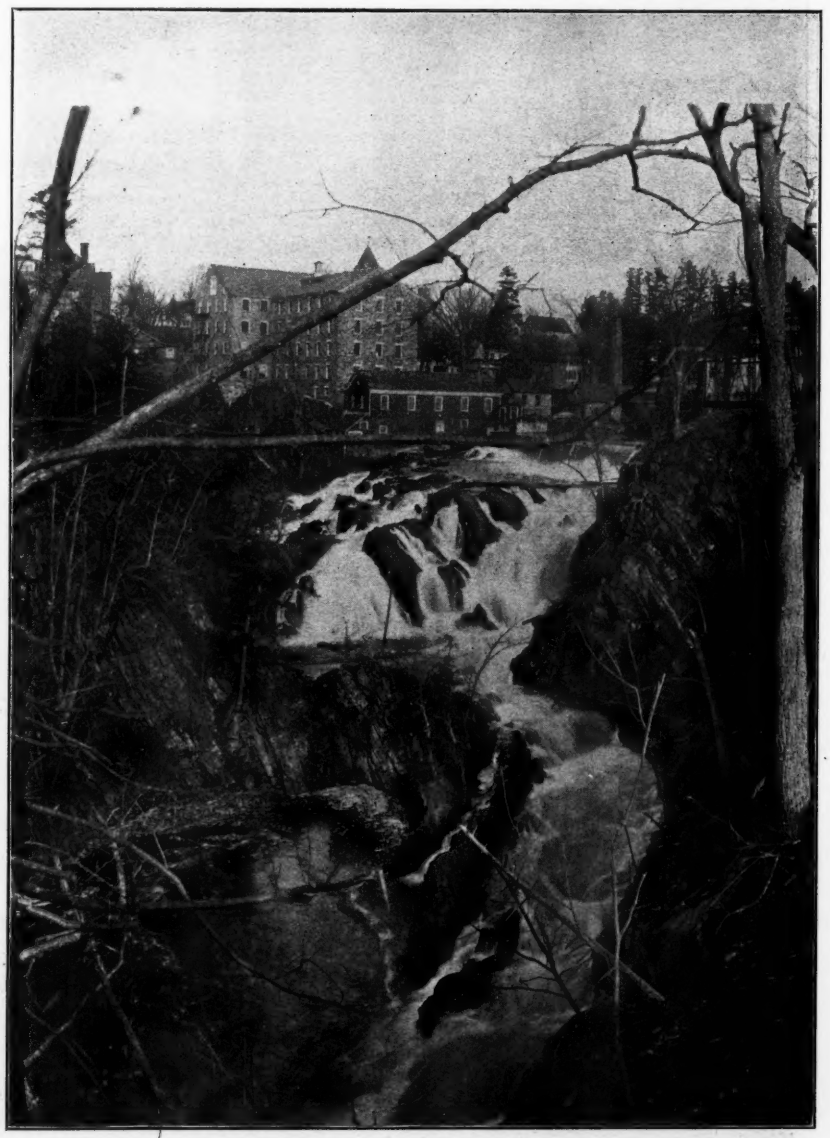
Relief Tubes Overflowing.

between the third rail and the track rails. The rotaries, when in operation, are in parallel on both sides and are started by means of direct current obtained from the direct-current machines operating the third-rail section near the power-house.

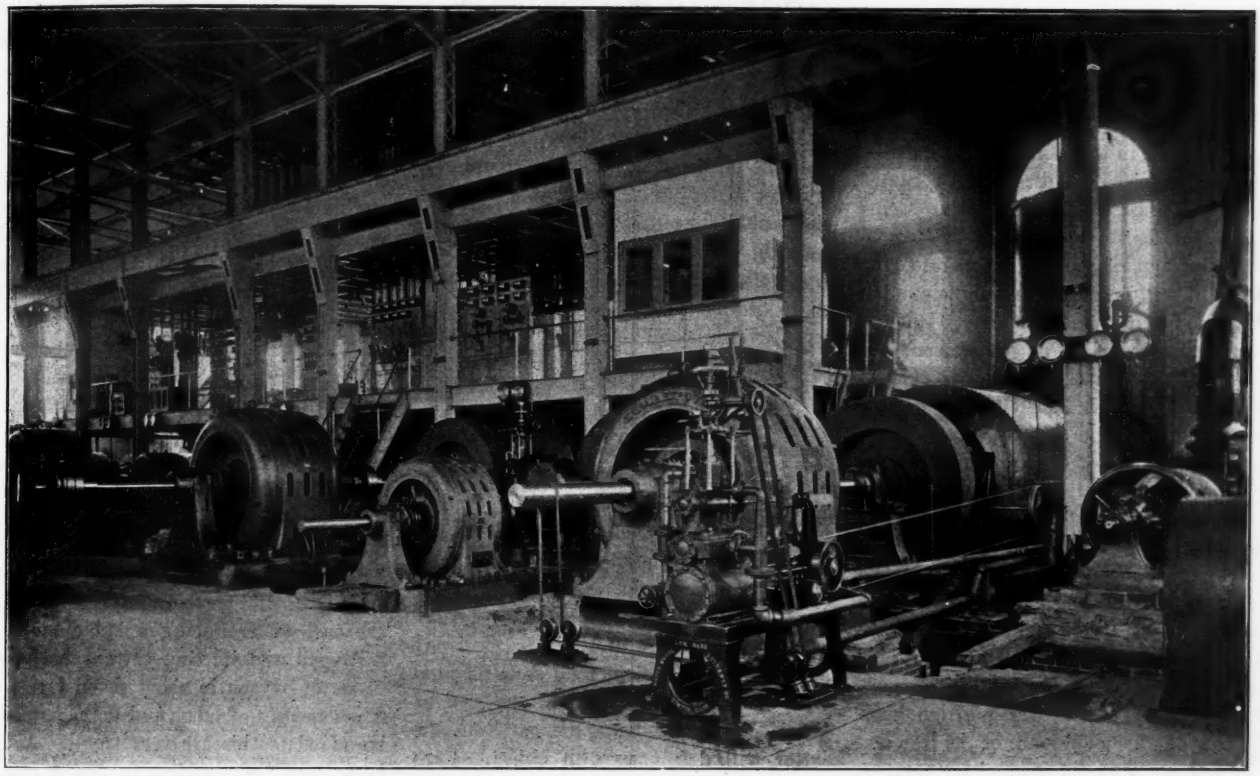
The auxiliary steam plant consists of two units, each of 550 horse-power, of Aultman & Taylor water-tube boilers, located in a brick building to themselves, and two engines. Of these, the larger is a vertical cross-compound condensing engine of 1,125 horse-power, arranged to drive one of the three-phase generators by means of belts. The second engine is similar to the other but of only 750 horse-power, and is arranged to be belted to the two 250-kilowatt lighting generators. The engines are of the Buckeye type and are worked condensing by means of Bulkley condensers.

The cars are 53 feet 6 inches long over all, and were built by the Wason Manufacturing Company, of Springfield, Mass. They are mounted each on two Brill trucks having 33-inch wheels, each truck carrying two General Electric motors of 75 horse-power each. The cars are equipped with Christensen air brakes and motor compressors. The cars weigh, empty, a total of 57,728 pounds each and operate at an ordinary maximum speed of 51 miles an hour. In addition to these cars there are box freight cars, used at present as electric locomotives for hauling standard freight cars over the railway. The ordinary day car seats 60 passengers, some of the cars being divided by a partition, making a smoking compartment of one end. Schedule time from Albany to Hudson is one hour and fifty-five minutes, there being between the two places 18 regular stopping points. Cars stop only at these stations, each of which has a station agent, baggage master, operator, etc., and in all respects the line is operated entirely upon a steam railroad basis.

The operation of this railway presents a great number of points of the highest interest, both to electrical engineers and to railway men. Connecting, as it does, two cities, one of which has a population of 110,000 people, while the other has 25,000 inhabitants, and passing through one of the richest and most beautiful agricultural regions in the country, it might naturally be supposed that through traffic in passengers would be an important feature of its business. A steam railroad, however, operating many trains connects the same points and has, up to lately, enjoyed a considerable portion of the passenger traffic by reason of a somewhat faster schedule. In order to develop the summer travel and pleasure travel, which are so important to an interurban railway, the Albany & Hudson company established at a point almost exactly in the middle of the line a park on the shores of Kinderhook Lake, a very beautiful body of water, and here has gathered the usual attractions found in suburban pleasure resorts. The amount of travel to the park may be estimated by the fact that on July 4 last, with only 10 cars in service, 10,000 people

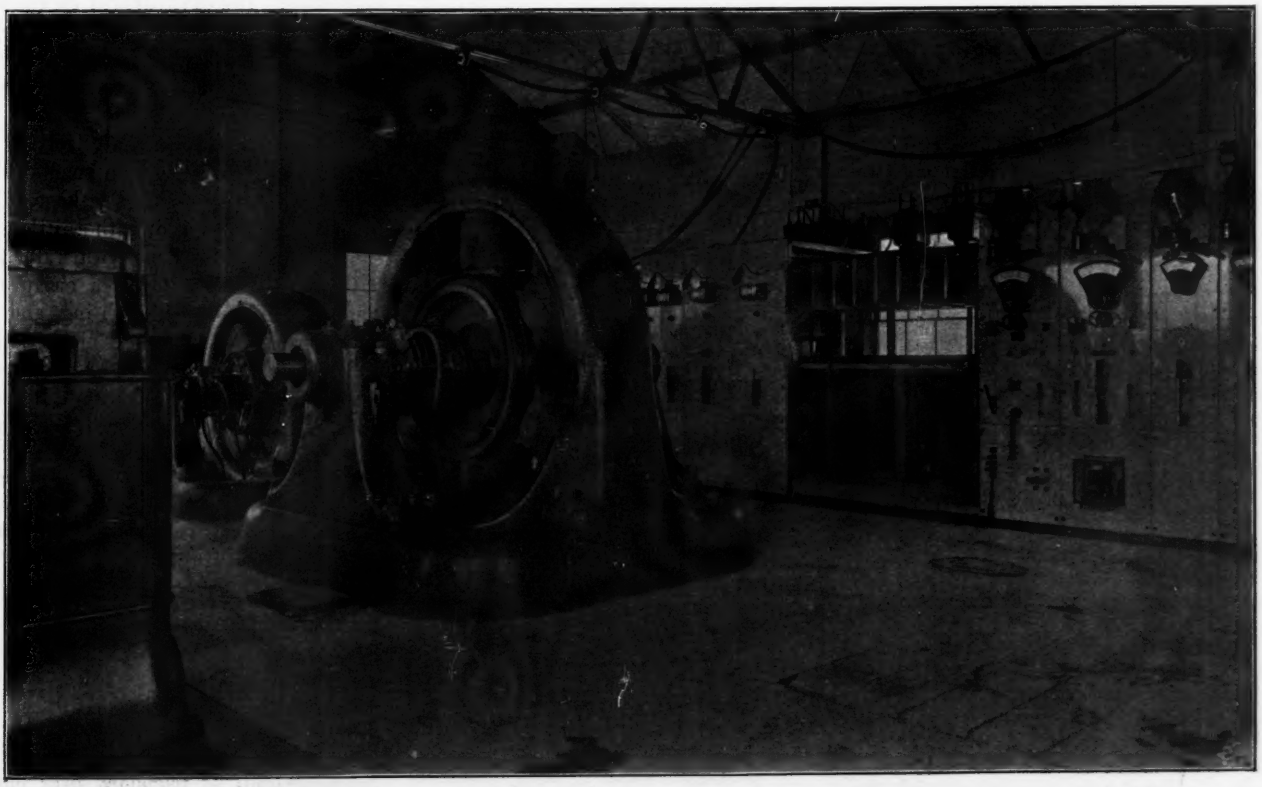


Lower Stuyvesant Falls, from which the Albany and Hudson Railroad Derives Its Water Power.



SOME OF THE RAILWAY AND LIGHTING GENERATORS AND THE SWITCHBOARD.

were carried to and from this park. The main business of the railway is in the transportation of local passengers from point to point, a considerable number of through passengers from Albany to Hudson and *vice versa*, and in handling freight to the various manufacturing towns and villages lying along the line. A rate of fare of somewhat less than one and one-half cents per mile is charged, the straight fare from terminus to terminus being 50 cents. Such freights as hay, coal and



INTERIOR OF SUBSTATION AT GREENBUSH ON THE ALBANY AND HUDSON RAILROAD.

other bulk goods are carried very often in the cars received from connecting steam railways, and it is expected that, with the development of the natural resources of the country through which the line runs, a large increase in this will shortly be made. The railway also handles United States mail and the American Express Company's packages over its lines.

Throughout the road is operated by means of written orders and signals, upon what is known as the duplicate system of train despatching. The despatcher's office is situated in the company's general office building at Rensselaer, which is across the river from Albany, and a double system of circuits has been installed for the purpose of train despatching. A standard telegraph line connects the 18 stations and, in addition, a line of No. 10 copper wires is run on the same poles with the high-pressure alternating feeder lines and on this are installed thirty-three high-power telephones. The wires for the telephone line are transposed at every fourth pole on Locke transposition insulators. The telephones are of the iron box type having powerful magneto generators and are bridged across the circuit. In the operation of the despatcher's office it is noticed that the telephone is used in preference to the telegraph, as being quicker and quite as accurate. Orders are written in triplicate, or else five copies are made by the usual carbon process, and the system of despatching is in all respects similar to that employed on single-track steam railways with sidings. In this way it is believed that every possible precaution has been taken to insure safety.

On account of the sharp curves encountered in the city of Albany it has not been found expedient to operate trail cars. When it is necessary to run more than one car as a train the second car is despatched about five minutes after the first one and runs as a second section of the same train, the usual signal flags used in steam railway practice being carried. So far no accidents of any kind have been ascribed to the third rail. The boys of the neighborhood have discovered that fireworks may be had by short-circuiting the lines with an iron wire, but in general this does nothing worse than blow the magnetic cut-out switches at one of the substations. No one has been injured by contact with the third rail, although many persons and some horses and cattle have received shocks from it.

The operating officers of the road are: Messrs. R. H. Runkle, president; A. C. Salisbury, second vice-president; George G. Blakeslee, general manager, and M. E. Stark, superintendent. To Mr. Blakeslee the ELECTRICAL REVIEW is indebted for many courtesies in connection with the data for the preparation of this article.

## COMMERCIAL ELECTROLYSIS OF WATER.*

BY ARTHUR MORRIS.

Although the electrolysis of water is a simple matter enough in the laboratory, it is not so easy to carry out on a commercial scale. The first difficulty is to prevent the gases evolved at the electrodes from mixing; and if this is done by means of an ordinary porous diaphragm the internal resistance of the cell is so much increased that the cost of production is largely augmented. If we take the electro-motive force normally required for the decomposition of water at 1.49 volts, if this is brought up to five volts by the use of a diaphragm, the effect of the power is lessened by 29 per cent, even theoretically. A much more economical method is to use a metallic diaphragm, which separates the gases perfectly. The fall of potential between the septum and either electrode ought to be insufficient for the decomposition of water; for it is obvious that if gas is disengaged from the partition the latter will defeat its own object. Care must therefore be taken, when such a partition is used, to keep the electro-motive force within bounds. It has been found that an iron partition in an alkaline electrolyte answers best in practice. The cheapest suitable electrolyte is a 14 per cent solution of caustic soda. There is a chance of trouble through absorption of carbonic acid from the air, which may cause a decomposition of carbonate of soda on the electrodes; but this can be prevented by pouring petroleum on the electrolyte, and so excluding it from the atmospheric action. Even this, however, is unnecessary if the temperature is allowed to get above 100 degrees centigrade. The steam then arising from the electrolyte keeps it from contact with the air.

One of the principal commercial applications of the electrolysis of water is the preparation of hydrogen for inflating balloons. For this purpose the gas should be as pure as possible, so that its lifting power may be a maximum, and the size of the balloon as small, therefore, as possible. This saves carriage of gas cylinders and oil-silk. Now, ordinary hydrogen, prepared from sulphuric acid and iron according to the process formerly universal among balloonists, is nearly twice as heavy, bulk for bulk, as the pure gas, while it is easy to get electrolytic hydrogen only 25 per cent heavier than the chemically pure element.

To electrolyze water in large quantities by power from a distant turbine it is usually necessary to convert the alternating current provided into a direct one. Motor transformers are to be preferred for this purpose. An automatic apparatus invented by Bassani should be used to check the density of the gas produced; and its state of purity from oxygen should be kept ascertained by passing it, on the way to the balloon, over hot spongy platinum, which will cause a small explosion if the percentage of oxygen becomes excessive. If very pure gas is wanted, the hydrogen should be passed through a tube, kept red hot, and provided with an apparatus for condensing any steam formed.

There is in Rome a factory for water electrolysis which makes 86 cubic metres of hydrogen per 1,000 horse-power-hours; and one in Brussels does better still with 120 cubic metres. In Rome a kilowatt costs 76s. 4d. per annum, which brings the cost of producing a cubic metre of hydrogen and its concomitant half cubic metre of oxygen to about seven farthings. The expenses of labor and management to be added to this are very small. A 100-horse-power plant, getting power from a central station, costs about £4,000.

The possible employments of the products of water electrolysis are very numerous. Blowpipe work is a very important one, especially for soldering lead for accumulators and vitriol chambers, and aluminum. The oxyhydrogen blowpipe is peculiarly suitable for the latter metal. For military ballooning water electrolysis is indispensable, for the reasons already given.

The chief drawback of electrolytic hydrogen is its freedom from smell. This makes it difficult to detect leakage. The best remedy is to mix it with a little mercaptan vapor, as is done with water gas.

Oxyhydrogen gas forms a cheap substance for incandescent lighting, and the hydrogen can also be used alone with a Welsbach mantle, or the oxygen alone, mixed with the vapor of benzole. In many cases oxyhydrogen gas is an efficient substitute for the electric furnace as a source of high temperatures.

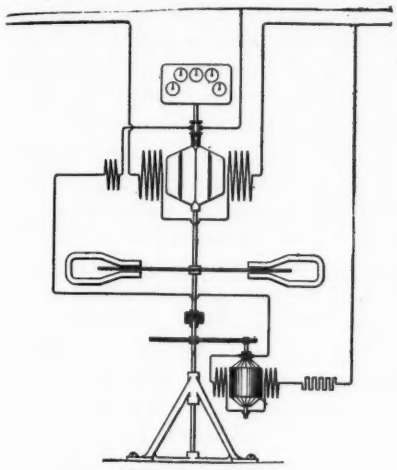
*From the *Electrochemist and Metallurgist*.

## Subterranean Telephone Lines in England.

The great success which has attended the operation of the London-Birmingham telegraph cable, which was laid underground for a distance of 113 miles, has prompted the post-office authorities to utilize the line as a telephone circuit. It is said to work very well, but to mark the practical limit of telephony over buried cables.

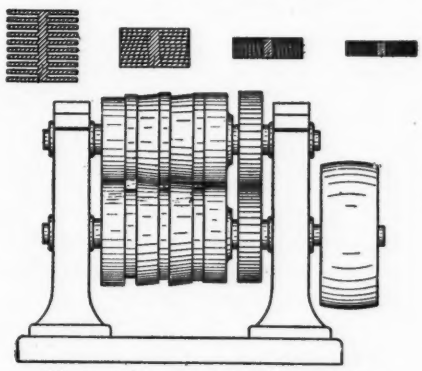
# Electrical Patents

Mr. Albert G. Davis, the attorney for the General Electric Company, has patented an improvement in electric meters, which he has assigned to the company. The present invention relates to means for



ELECTRIC METER.

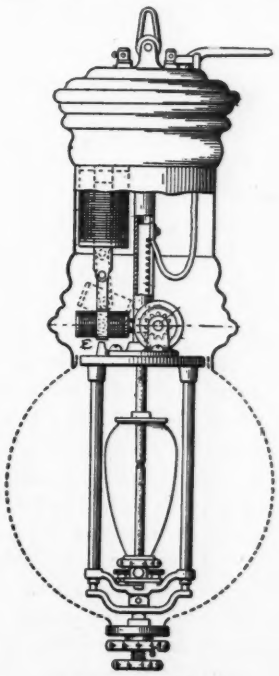
reducing friction in electric meters and other devices having relatively movable parts. In meters the friction which tends to restrain the rotation of the movable member is always objectionable, and particularly so when the meter runs on light loads for any considerable portion of its period of operation. A considerable portion of the friction is due to the jewel or other bearing for the lower end of the meter shaft, and it is this friction which the inventor causes to be eliminated by positively rotating the jewel or other bearing at a speed approximating the mean speed of the meter armature. The meter consists of the field coils, in series with the mains, and the armature, connected in a circuit across the mains. The armature shaft carries the usual retarding disk, which cooperates in the ordinary manner with retarding or damping magnets. The lower end of the shaft is carried by a jewel or other bearing. This bearing, instead of being stationary, as has been the usual practice heretofore, is in accordance with this invention caused to rotate in the same direction as the shaft, thereby doing away almost, if not entirely, with relative motion between the said bearing and the lower end of the shaft, and thereby with the friction occasioned by such relative motion. The means for securing motion of the supporting bearing may assume a large variety of forms, as will be evident to one skilled in the art. In the patent, however, there is shown a satisfactory mechanism for accomplishing this result, the mechanism in this instance consisting of a small series motor geared, by means of a pinion, to a larger gear-wheel, fixed to a shaft, which at its upper end carries the bearing and is itself supported by a suitable step or framework. The motor is connected in series with the armature circuit of the meter, this circuit including, if desired, the usual resistance. Since the series motor might, under certain circumstances, tend toward an indefinite speed of rotation, and thereby, by reason of its counter electro-motive force, act to cut down or choke off the current flowing in the circuit of the meter armature, it is provided with a suitable load, which in this case may consist of a cylinder of copper or other conducting material surrounding and carried by the armature of the motor. If desired, the armature winding, instead of being located inside, may, of course, be placed outside of the metal sleeve or damping device. It will be evident that as the motor armature rotates currents will be induced in this metal sleeve which acts to retard the motion of the armature, thereby constituting a mechanical load.



MAKING ACCUMULATOR ELECTRODES.

Herr Heinrich F. Hobel, of Berlin, has patented in this country a new process for making accumulator electrodes, especially of that class used in the Planté system. As is well known, it has hitherto been desired to extend the surface of such electrodes as much as possible; but it is not possible to develop the surfaces any further by means of the processes already known. Electrodes, the active ribs or teeth of which are designed to be only 0.1 millimetre thick, can be made neither by casting nor stamping, as they can not be got out of the molds or rollers without breaking. Nevertheless, for automobiles and transport purposes generally a further development of the surfaces is very desirable. This may be attained, according to this improved process, by providing a lead structure which consists of a central wall and ribs projecting therefrom, with a thin surface covering, and then passing the electrode between rolls by which the ribs are rolled out thin against one another. The thin surface covering is for the purpose of keeping the ribs separate from each other during the rolling and preferably consists of a thin coating of peroxide of lead or an easily soluble paint. Lead strips may be employed as suitable forms of construction as well as plates. With lead plates, in order to be able to roll the ribs out thin lengthwise, they must incline toward the solid central piece, preferably vertical to the central piece.

Professor Elihu Thomson has devised an improvement for arc lamps, the object being to effect a more sensitive and quickly responsive carbon feed by appliances of a simple and cheap construction. Broadly, the invention consists of a clutch which acts instantly to arrest or release the movable carbon at the required moment, the engaging parts which establish or release the disengagement being in a practically uniform relation at all times and clutching or unclutching by the establishment of a magnetic field around the engaging parts which is under the control of the arc. Thus the device is practically free from all defects arising from sluggish control due to inertia of masses of metal, and the feed is effected or arrested at perfectly definite limits, which may be made as narrow as desired and which conduce to the maintenance of a very steady arc. An effective method consists of an iron armature controlling the movement of the movable electrode, in close relation to which is a magnetic pole, the strength of which may be varied to lock the armature or to permit it to slip in accordance with the variations of arc length. The arc may be sprung in any suitable manner—a very convenient manner being to mount one element of the clutch in a support controlled by an auxiliary electromagnet under the influence of the lamp current. Thus the lamp is started into action by



ELECTRIC ARC LAMP.

springing the arc under the influence of the auxiliary electromagnet and establishing a periodical feed by the variations of magnetic strength in the parts of the gripping clutch.

## THE FRANCHISES OF TELEPHONE AND TELEGRAPH COMPANIES, LEGISLATIVE, MUNICIPAL AND CONGRESSIONAL.*

BY G. C. HAMILTON.

Primary amongst the questions confronting jurists and legislators of to-day is that concerning the granting of franchises to those creations of the law which owe their inception to the progress of modern scientific invention—telephone and telegraph companies. Although, in a measure, novel in their uses, but few new legal questions have arisen because of their existence, none to the adjudication of which well-settled legal principles have not been sufficient. Very little special legislation, on their behalf, has been enacted, or indeed required. That which has found its way into the statute book of the communities in which such electrical corporations exist has been enacted largely with a view to afford facilities for the better operation of scientific improvements, which are, in their very nature, of inestimable value to the general public. The residue of special enactments of this kind has been found necessary to restrain such corporations from exercising powers that are not essential to their existence and which have proved detrimental to already existing and well recognized rights.

The granting of franchises is a power that, unfortunately, has not always been exercised with proper caution, though a rigid conservatism in this respect, tending as it would to nullify and defeat the rapid strides of scientific invention and improvement, would undoubtedly prove deplorable, if not actually disastrous. A franchise being "a branch of the sovereign prerogative subsisting in the subject by a grant from the sovereign,"[1] the delegation of such power should be primarily beneficial to the sovereign public, then, to the grantee. Shaw, C. J.,[2] well defines the extent of legislative power in this respect; he says: "In addition to the law-making power, the legislature is the representative of the whole people, with authority to control and regulate public property and public rights, to grant lands and franchises, to stipulate for, purchase and obtain all such property, privileges, easements and improvements as may be necessary or useful to the public, to bind the community by their contracts therefor, and generally to regulate all public rights and interests."

Of greatest moment, in regard to the franchises of telephone and telegraph companies, is their use of the streets, their existence upon the highways. Under the old English common law, the easement in a highway was the property of the king as universal trustee;[3] it consequently, under our form of government, becomes the property of the people, unless otherwise stipulated, may be disposed of by their representatives, and is subject to the absolute control of the legislature. The regulation of the streets is ordinarily given to a municipal corporation for corporate purposes only and is even then subject to the paramount control of the legislature as regards general and more extended uses.[4] The technical fee to the land may remain where it will, either in the adjacent owner or in the public, for as long as the land is preserved as a common highway, the rights of the technical owner are subrogated to the easement to such an extent as to practically cease to exist.[5] To divest itself of the control of the streets, and to vest a municipality with power to grant particular franchises, that in any manner affects the common easement enjoyed by the public, special action by the legislature is necessary and the municipality must be so empowered, expressly, or by direct implication.[6]

The legislative power to grant franchises is, in general, absolute, for, except when prohibited or restricted by the provisions of the state constitution, the legislature is fully empowered to grant all franchises, even if they be exclusive, within its own jurisdiction.[7] For a municipal corporation to grant exclusive franchises over the streets, it must possess the whole sovereign power and control of the highways, delegated to it by the legislature.[8]

It has been, and is, the practice of telephone and telegraph construction to follow, in so far as possible, the lines of streets and highways, as affording facilities otherwise not obtainable. It is not the purpose of this article to discuss the mooted question of compensation to the abutting owner, but rather the legal necessity of legislative sanction to enable these electrical companies to pursue this course. Jackson, J., says:[9] "It is well settled that the right to use the streets and other public thoroughfares of a city for the purpose of placing therein or thereon pipes, mains, wires and poles for the distribution of gas, water or electric lights, for public or private use, is not an ordinary business in which any one may engage, but is a franchise belonging to the government, the privilege of exercising which can only be granted by the state or by the municipal government of the city acting under legislative authority." This view has led to two very interesting lines of decisions. In the one, it is contended that the legislature stands simply as trustee for the easement of the public in the highway, and, as trustee, takes no greater title than is necessary to the proper execution of the trust. Hence it possesses no power to grant franchises to telegraph and telephone companies for the erection and maintenance of poles and wires upon the highways, and, though it is tacitly admitted that the granting of franchises to such companies is a proper exercise of legislative authority, the existence of such poles and wires upon the public streets is held to be contingent upon a grant from the abutting owner in whom the fee remains.[10] In the second line of decisions, it is held that the construction of such lines, and their maintenance upon the streets, is a use similar to that for which the highways were acquired and constitute no additional foreign burden upon the fee.[11] Hence the power to erect poles and string wires, provided the public easement in the highway is in no wise obstructed, is held to be a privilege conferred upon telephone and telegraph companies by, and in, the granting of a franchise to them.

As to the construction of franchises granted to telephone and telegraph companies, there can be no question. Every grant of a franchise, or in the nature of a franchise, is to be construed strictly.[12] Nelson, J., in the case of Minturn *vs.* Larne,[13] says: "It is a well-settled rule of construction of grants by the legislature to corporations, whether public or private, that only such powers and rights can be exercised under them as are clearly comprehended within the words of the act, or derived therefrom by necessary implication, regard being had to the objects of the grant. Any ambiguity or doubt arising out of the terms must be resolved in favor of the public." Once granted, however, a franchise assumes the nature of a contract, and the state is bound by the grant of the rights, so conveyed by the legislature, even though they be exclusive, provided they are not in conflict with the constitution.[14]

Whether the grant of a franchise can be resumed, by the legislature, or its substantial advantages impaired, without the consent of the grantees, presents still another interesting question. Van Sycle, J.,[15] considers the power of the legislature, so to resume or impair a franchise, extremely doubtful, and says: "It is in the nature of a contract, and those who procured the passage of the act having entered upon the development of their

*From the *American Law Register*.

scheme and made large outlays in its promotion, have acquired rights which must be regarded." A view that, because of a proper and fitting regard for vested rights, has been very generally taken.[16] So it has been held that a subsequent statute interfering with, restricting, or tending to nullify a previously granted franchise, or the rights thereunder acquired, is, in so far as it so interferes, inoperative and void.[17] And, while the legislature is empowered to exercise the police power of a state, subject to the power of the court to adjudicate the question as to whether any particular enactment is an invasion of the constitutional rights of the individual, it may not, under the guise of protecting public interests, interfere with or restrict private business.[18]

The primary question, in the granting of franchises to telephone and telegraph companies by a municipality, is that concerning the authority of the particular municipal corporation, in question, to make such grants. The question at issue is, necessarily: Has the legislature expressly, or by necessary implication, in the granting of the municipal charter, or by subsequent legislative enactment applicable to such municipality, delegated to it such portion of the legislative authority as is necessary to the lawful exercise of such power?[19] If general control over the streets has been so granted, the municipality may clearly grant franchises for the use of the streets, provided no additional burden is imposed upon the fee.[20] As to the necessary method of action, Van Vleet, V. C., says:[21] "Where no method is prescribed in which a municipality shall exercise its power, but it is left free to determine the manner for itself, it may act either by resolution or by ordinance. One method is just as effectual in point of law as another."[22] In pursuance of such delegated authority, a municipality may grant a franchise that shall be in its nature exclusive, conveying thereunder rights that the city may not subsequently impair nor restrict.[23] Nevertheless, the franchise so granted acquires simply the nature of a contract, and if the telephone or telegraph company erects its poles and wires under authority of an ordinance, which provides for the expiration of its privileges on and after a certain date, such company is possessed of no legal right to maintain such equipment, within the corporate limits, after the life of such grant.[24] So the passage of an ordinance by a municipality, permitting the erection of poles and wires by a telegraph company on conditions of benefit to the city, the acceptance of the ordinance by such company, and the subsequent enjoyment of the benefits by the municipality, constitute all the necessary essentials of an executed contract which the city may not violate.[25]

Telephone and telegraph companies are, however, properly subject to municipal regulation, irrespective of the authority granting the franchises under which they operate. The imposition of suitable conditions, regulations and restrictions, in the form of municipal ordinances, is to be supported as a proper exercise of the police power of a city, provided they do not evidence a desire to oppress, or unwarrantably control the maintenance and operation of telephone and telegraph lines within the city.[26] So an ordinance requiring such electrical companies to place their wires in conduits is a proper exercise of municipal police power;[27] likewise a charge, in the nature of a rental, for the exclusive use of parts of the streets;[28] and a city may lawfully impose a tax upon the poles and wires of telephone, or telegraph companies, maintained within the corporate limits, to cover the expense to which the municipality is subjected, in the enforcement of its police regulations, because of the maintenance of such equipment upon the streets of the city;[29] but such tax must be fair and reasonable, and a municipality, in the exercise of its police power, may not impose exorbitant charges, nor seek to derive from such taxation revenue vastly disproportionate to the actual outlay for supervising and inspecting such poles and wires.[30] Indeed, the whole question of the proper municipal regulation of these and kindred electrical companies is one of the greatest nicety. On the one hand, we have arrayed the inviolability of existing rights, possessing all the attributes of the consideration of an executed contract, together with the natural desire to promote and facilitate the operations of creatures that so largely tend to improve and widen the scope of business enterprise and social comfort; on the other hand, the necessity for a fitting regard for the safety of the community and for the proper preservation of the rights of its individual members.

The powers of Congress, as to the franchises of telephone and telegraph companies, are those conveyed by the Federal Constitution. Article 1, section 8, of the Constitution, which confers upon Congress the power to regulate interstate commerce, permits the states to regulate matters of local interest, which affect, only incidentally, commerce between the states, but the authority of Congress is universal and exclusive where the matter is characteristically national. If Congress fails to act and provides no law for the regulation of commerce between the states, of that nature which makes congressional jurisdiction exclusive, it thereby indicates its desire that such commerce shall not be the subject of state regulation.[31] So a state will not be permitted to restrict, or impose burdens upon the transmission of messages by telephone or telegraph companies, from one state to another.[32] Nevertheless, such companies owe obedience to the laws of the state within which they are located and are under obligations to pay their fair share of the taxes necessary for its support,[33] when levied upon their real or personal property within the jurisdiction of the state.[34] Telegraphic and telephonic communication between the states is part of their commercial intercourse and so properly subject to the control of Congress,[35] and state franchises granted to such companies as operate interstate lines are subject to congressional control, in so far as it may be necessary to control them for the regulation of commerce.[36]

Acting upon these premises, Congress, July 24, 1866, passed what is known commonly as the "Telegraph Act." It may be stated, at the outset, that there can be no doubt that telephone, as well as telegraph, companies, are included within the provisions of this legislation.[37] The first paragraph of the act, which alone is of importance in this discussion, provides that telegraph companies, organized under the laws of any state, may construct, maintain and operate their lines over any part of the public domain, military or post roads, and under or across any navigable streams of the United States, provided they do not interfere with ordinary travel, or in any way obstruct the same.[38] The court, in the case of the Pensacola Telegraph Company *vs.* the Western Union Telegraph Company,[39] defining the powers acquired under the act, says: "It gives no foreign corporation the right to enter upon private property, without the consent of the owner, and erect the necessary structures for its business; but it does provide that, whenever the consent of the owner is obtained, no state legislation shall prevent the occupation of the post roads for telegraph purposes by such corporations as are willing to avail themselves of its privileges." So a telegraph company may not, relying upon this act, occupy the streets of a city without compensation[40] and, although all railroads are post roads,[41] a telegraph company is given no right to occupy the right of way of a railroad, with its lines, without the

consent of the railroad company.[42] On the other hand, the railroad company may not make an exclusive contract of this nature[43] and a telegraph company may acquire right of way over a railroad, without the consent of the latter, by due process of law.[44]

The question of state taxation of companies accepting the benefits of the act of 1866 has given rise to a multitude of decisions. There can be no doubt as to the right of the state to impose taxes upon business carried on wholly within its jurisdiction,[45] but a specific tax upon each message transmitted beyond the state is unconstitutional,[46] and a tax upon the franchise of such a company is void;[47] nor may a state impose a tax upon messages partly within the state.[48] Strong, J., in the case of the Railroad *vs.* Penniston,[49] discussing the question of state taxation of federal agencies, says: "It is, therefore, manifest that the exemption of federal agencies of taxation is dependent, not upon the nature of the agent, or upon the mode of their constitution, or upon the fact that they are agents, but upon the effect of the tax; that is, upon the question whether the tax does in truth deprive them of power to serve the government as they were intended to serve it, or does it hinder the efficient exercise of their power." An opinion that states clearly and briefly the true rule by which state taxation of companies operating under the "Telegraph Act" must be measured.

Telegraph companies enjoying the privileges of the act of July 24, 1866, do so in subordination to the due exercise of the police power of the state in which their lines are situated;[50] the rights so given are permissive only and properly subject to all state and local legislation regulating their exercise. So a municipality, under the exercise of its police power, may enact and enforce ordinances intended to promote the safety and convenience of the public in its use of the streets;[51] but where such regulations and restrictions are excessive, or evidence a desire to oppress, control or defeat the company's existence, they are void.[52] It is not the intention of the act of July 24, 1866, to do more than exercise a proper control of a business, whose very nature makes its operations interstate commerce, but neither state nor municipality may enact laws that hinder the exercise of the powers, the enjoyment of the privileges Congress has so conferred upon electrical companies of this nature. Nevertheless, a proper interpretation of the law demands that telephone and telegraph companies operating under the act be subject to legislation that is simply the due exercise of the police powers of the state or municipality.

1 3 Bl. Com. 37; Finch, 164; 3 Cruise Dig. tit. 27, par. 1.
2 B. & L. R. R. *vs.* Salem & L. R. R., 2 Gray, 32.
3 1 Rolle Abr. 392; Goodtitle *vs.* Alker, 1 Burr. 143.
4 Phila. & Trenton R. R., 6 Whart. 25.
5 Sullivan *vs.* R. R. Co., 51 N. J. L. 518; Improvement Co. *vs.* Hoboken, 36 N. J. L., 540; R. R. Co. *vs.* Newark, 10 N. J. Eq. 352.
6 Phila. & Trenton R. R. *vs.* Hoboken, 35 N. J. L. 208.
7 Gibbons *vs.* Ogden, 9 Wheat. 1; West River Bridge *vs.* Dix *et al.*, 6 How. 507; Shorter *vs.* Smith, 9 Ga. 529; New Hampshire Bridge *et al.*, 7 N. H. 35; Cal. Teleg. Co. *vs.* Atl. Teleg. Co., 22 Cal. 398; Hazen *vs.* Union Bank, 1 Sneed (Tenn.), 115.
8 Waterworks vs. Atl. City, 39 N. J. Eq. 367; Grd. Rpds. E. L. & P. Co. *vs.* Grd. Rpds. Edison E. L. & F. G. Co., 33 Fed. Rep. 659.
9 Grd. Rpds., etc., Co. *vs.* Grd. Rpds. Ed., etc., Co., 33 Fed. Rep. 659.
10 Mut. Tel. & Tel. Co. *vs.* Colwell Lead Co., 67 How. Pr. 365; B. of T. Tel. Co. *vs.* Barnett, 107 Ill. 507; W. U. Tel. Co. *vs.* Williams, 86 Va. 696.
11 Pierce *vs.* Drew, 136 Mass. 75; Boston *vs.* Richardson, 13 Allen, 146; Atty. Gen. *vs.* Met. R. R., 125 Mass. 515.
12 U. S. *vs.* Arredondo, 6 Pet. 738; Beaty *vs.* Knowler, 4 Pet. 168; Providence Bank *vs.* Billings, 4 Pet. 514; Charles River Bridge *vs.* Warren Bridge, 11 Pet. 420.
13 23 How. 436.
14 Charles River Bridge *vs.* Warren Bridge, 7 Pick. 344.
15 State *vs.* Blake *et al.*, 35 N. J. L. 208.
16 Planters' Bank *vs.* Sharp., 6 How. 301; People *vs.* Manhattan Co., 9 Wend. 351; Bridge Co. *vs.* Hoboken Co. 2 Beas. 81.
17 Dartmouth College *vs.* Woodward, 4 Wheat. 518; State Bank of Ohio *vs.* Knoop, 16 How. 369; Farrington *vs.* Tenn., 95 U. S. 679; Fletcher *vs.* Peck., 6 Cranch. 135; Dodge *vs.* Woolsey, 18 How. 331.
18 Lawton *vs.* Steele, 152 U. S. 137; Mugler *vs.* Kansas, 123 U. S. 623.
19 2 Dillon Mun. Corp., par. 680.
20 Pelton *vs.* E. Clev. Ry. Co., 22 Week. L. Bul. 67.
21 Halsey *vs.* R. T. St. Ry. Co., 20 Atl. Rep., 859.
22 State *vs.* Jersey City, 27 N. J. L. 493; Burlington *vs.* Dennison, 42 N. J. L. 165; Butler *vs.* Passaic, 44 N. J. L. 171
23 Teachout *vs.* Des Moines B. G. R. R. Co., 75 Iowa, 722.
24 Mut. Un. Tel. *vs.* Chicago, 16 Fed. Rep. 309; So. Bel. Telep. Co. *vs.* Richmond, 98 Fed. Rep. 671.
25 St. Louis *vs.* W. U. Tel. Co., 63 Fed. Rep. 68; New Orleans *vs.* So. T. & T. Co., 40 La Ann. 41; Chicago *vs.* Sheldon, 9 Wall. 50; Kentucky *vs.* Corrigan, 86 Mo. 67.
26 Richmond *vs.* So. Bell Telep. Co., 174 U. S. 761.
27 W. U. Tel. Co. *vs.* Mayor, 38 Fed. Rep. 552.
28 St. Louis *vs.* W. U. Tel. Co., 149 U. S. 465.
29 Phila. *vs.* W. U. Tel. Co., 32 C. C. A. (Pa.) 246.
30 Phila. *vs.* W. U. Tel. Co., 81 Fed. Rep. 948.
31 Brown *vs.* Houston, 114 U. S. 622; Gloucester Ferry Co. *vs.* Pa., 114 U. S. 196; Walling *vs.* Mich., 116 U. S. 446; Pickard *vs.* Pullman So. Car Co., 117 U. S. 34.
35 Ry. Co. *vs.* Ill., 118 U. S. 557.
33 Teleg. Co. *vs.* Mass., 125 Mass. 548.
34 W. U. Tel. Co. *vs.* Ala., 132 U. S. 472; W. U. Tel. Co. *vs.* Charleston, 163 U. S. 711.
35 W. U. Tel. Co. *vs.* Atl., etc., Co., 5 Nev. 103.
36 Gibbons *vs.* Ogden, 9 Wheat. 205.
37 Cumb. T. & T. Co. *vs.* Un. El. Ry., 42 Fed. Rep. 273; Wis. Tel. Co. *vs.* Oshkosh, 62 Wis. 32; C. & P. Tel. Co. *vs.* B. & O. Tel. Co., 62 Ind. 410.
38 Rev. Stats. U. S., par. 5263.
39 96 U. S. 1.
40 St. Louis *vs.* W. U. Tel. Co., 148 U. S. 92.
41 Rev. Stats. U. S., Sec. 3964.
42 W. U. Tel. Co. *vs.* Ann Arbor R. R. Co., 90 Fed. Rep. 379.
43 W. U. Tel. Co. *vs.* B. & O. Tel. Co., 19 Fed. Rep. 660; Postal Teleg. Co. *vs.* W. U. Teleg. Co., 50 Fed. Rep. 493.
44 Mercantile Trust Co. *vs.* A. & P. Ry. Co., 63 Fed. Rep. 513; Postal Tel. Co. *vs.* Southern Ry. Co., 89 Fed. Rep. 190; Postal Tel. Co. *vs.* Clev. Ry. Co., 94 Fed. Rep. 234.
45 Rattermann *vs.* W. U. Tel. Co., 127 U. S. 411.
46 Teleg. Co. *vs.* Tex., 105 U. S. 460.
47 San Francisco *vs.* W. U. Tel. Co., 31 Pac. Rep. 10.
48 *In re* Penn. Tel. Co. (N. J.), 20 Atl. Rep. 846.
49 58 Wall. 5.
50 Richmond *vs.* Bell Tel. & Tel. Co., 174 U. S. 761.
51 Mich. Tel. Co. *vs.* Charlotte, 93 Fed. Rep. 11.
52 Richmond *vs.* So. Bell Tel. & Tel. Co., 174 U. S. 761.

## Metallic Calcium in Calcium Carbide.

In a recent article on the analysis and purification of acetylene, Rossel and Landriset quote figures which show that the proportion of hydrogen by volume in commercial acetylene usually ranges from 0.2 to 0.3 per cent, and does not exceed the latter limit even when the carbide is made in the presence of an excess of lime, says the London *Electrical Review*. Using an alternating current in the furnace, part of the lime excess volatilizes and part melts without decomposition, yielding a carbide of specially fine crystalline appearance; only the small residue is dissociated to metallic calcium, and, according to the present authors, only that part of the residue which happens to be in the middle of the finished lumps of carbide remains as metal and generates hydrogen when it comes in contact with water. Hydrogen in acetylene is objectionable since, burning as it does with a non-luminous flame, it reduces the illuminating power of the crude gas. It is known that a considerable quantity of hydrogen may exist in acetylene when the gas has been generated in a faulty apparatus which encourages overheating, and the quantity may easily reach a figure that seriously affects the readings of the photometer. This hydrogen is due to various decompositions occurring in the process of evolution, and it can be totally avoided by proper construction of the generating plant. The hydrogen arising from the metallic calcium of the carbide is naturally unavoidable; but Rossel and Landriset clearly show that its amount is too small to be in the least degree sensible to the consumer. Indeed, it is difficult to understand how any appreciable amount of metallic calcium can appear in a material made in an alternating furnace, where true electrolysis is theoretically excluded.

# Book Reviews

**"A B C of the Telephone," by James E. Homans. Theo. Audel & Company, publishers, New York. Cloth. 335 pages, 268 illustrations, 5 by 7¼ inches. Furnished by the ELECTRICAL REVIEW at $1.**

Mr. Homans has given us a really practical and excellent handbook of the telephone. He begins his description by brief reference to the apparatus and how to use it and then takes up the theory of sound, which is necessary to the understanding of the telephone. A brief survey of the principles of electricity follows and the history of the telephone is given in an interesting chapter. The subject is then taken up more in detail, showing various modifications of transmitters and receivers, the variety of circuits used in telephone work, discussion of subscribers' station apparatus, switchboards, central energy systems, party lines, intercommunicating systems and line and cable construction. The book is well indexed and contains a large number of useful hints and don'ts. It is the best book for the general reader or the beginner in telephone work that has ever appeared.

**"The Story of Nineteenth Century Science," by Henry Smith Williams. Published by Harper & Brothers, New York. Cloth. 475 pages, many illustrations and portraits, 5½ by 8 inches. Supplied by the ELECTRICAL REVIEW at $2.50.**

Dr. Williams has produced a most entertaining and readable book. It is written for the intelligent layman and is entirely free from technicalities, but at the same time it gives perhaps a better general view of scientific progress than any work which has appeared in recent years. The style of the author is entertaining and the beauty of the illustrations and typography adds greatly to the value of the book. It is one that contains much information of value to the professional or business man who desires to extend his general culture by the inclusion of some scientific information. Nothing is more interesting than the history of scientific development and its story is told in a captivating manner in this excellent volume.

**"Engineering and Electric Traction Pocketbook," by Phillip Dawson. John Wiley & Sons, publishers, New York. Morocco. 4 by 6 inches, 1,305 pages, 1,300 illustrations, 947 tables. Supplied by the ELECTRICAL REVIEW at $4.**

In producing the second edition of his excellent work, Mr. Dawson has revised it and enlarged it, bringing it up to date as nearly as possible and, while expunging some of the redundant matter of the first issue, has added much that is of great value. Two new sections have been added. One on "Gas Engines and Producers," and one on "Electrical Power in Factories and Workshops." While the work is English, American practice is by no means neglected in it, and it is a valuable compendium of information and formulæ. The term pocketbook is somewhat a misnomer, as the book is two and one-half inches thick.

**"Les Automobiles Electriques," by Gaston Sencier and A. Delasalle. Published by Vve. Ch. Dunod, Paris. Paper. 6 by 10 inches, 400 pages, 192 illustrations. Supplied by the ELECTRICAL REVIEW at $5.**

For some time past this important work has been awaited with interest by automobilists and manufacturers on both sides of the Atlantic. Upon its appearance it was awarded a gold medal by the Automobile Club of France, and it may justly be said to be the first complete work that has been written upon this subject. The information given in it is complete and exceedingly practical and, while it deals very largely with French apparatus, American automobiles have not been forgotten. It is to be hoped that the valuable work of MM. Sencier and Delasalle may soon appear in an English translation.

**"Electrical Designs." Reprinted from the *American Electrician*. Cloth. 262 pages, 289 illustrations, 6 by 9 inches. Furnished by the ELECTRICAL REVIEW at $2.**

This work comprises a large number of designs of small motors, testing instruments and other apparatus, with working drawings for each design. The original articles, of which it is a compilation, were the product of a large number of authors, and each is distinctly practical and simple. Amateurs and students of electricity, especially those who like to make things with their own hands, will find it a highly interesting and instructive work. A large number of the designs given are exceedingly ingenious and many of the simple machines described are both easy to make and excellent when completed.

**"Nature's Miracles." Volume 3. Electricity and Magnetism, by Elisha Gray. Published by Fords, Howard & Hulbert, New York. Cloth. 248 pages, several illustrations, 4 by 6 inches. Supplied by the ELECTRICAL REVIEW at 60 cents.**

The subordinate title of this posthumous work of the late Professor Gray sufficiently defines its character. He calls it "Familiar Talks on Science." The book is one that begins at the beginning and gives a history of the science, together with many anecdotes gathered during the author's long experience. It is exactly the book that the lay reader will find interesting and profitable.

**"The Induction Motor," by B. A. Behrend. Published by the *Electrical World and Engineer*, New York. Cloth. 105 pages, 56 illustrations, 6 by 8½ inches. Supplied by the ELECTRICAL REVIEW at $1.50.**

Mr. Behrend has produced a valuable book. His wide acquaintance with the subject matter lends particular authority to his statements and the method of handling the subject is perhaps the best that could be devised. This method is largely graphical, although the results are checked as far as possible by analytical methods, and the book is one that will doubtless be found useful in the workshop and designing room, as well as highly instructive to engineers who have to use induction motors in their regular work.

**"A Little Book of Tribune Verse," by Eugene Field. Tandy, Wheeler & Company, Denver, Colo.**

To any one familiar with the work of Field this posthumous collection of the verses printed in the Chicago *Tribune* while the author was its associate editor will appeal most strongly. The poems are typical of Field's best work and possess the gracious, kindly humor that so endeared the author to his associates and the outside world. The present volume is edited by Mr. Joseph G. Brown, who, from his long intimacy with Mr. Field, is well qualified to edit his work. The book is well worth reading.

**"Induction Coils. How to Make, Use and Repair Them," by H. S. Norrie (Norman H. Schneider). Spon & Chamberlain, New York, publishers. Cloth. 282 pages, 79 illustrations. 5 by 6½ inches. Supplied by the ELECTRICAL REVIEW at $1.**

This is a second edition, thoroughly revised and brought up to the latest American practice. In the new edition much space is given to medical and bath coils, gas engine and spark coils, contact breakers, primary and secondary batteries, gas lighting and any method of X-ray work. A chapter on wireless telegraphy is of considerable interest. The book is elaborately indexed.

**"Conduit Wiring and Construction," by L. M. Waterhouse. Published by S. Rentell & Company, London. Cloth. 80 pages, many illustrations, 5 by 7 inches. Supplied by the ELECTRICAL REVIEW at 75 cents.**

This book is a description of methods of wiring with Simplex enamel steel conduit as practiced in England.

### Electric Motors in Mines.

Electricians are preparing to install a system of wires in the Quincy mine, near Houghton, Mich., for the purpose of operating electric locomotives. The new system will largely displace the use of manual labor and will also provide better lighting facilities. Two locomotives, each capable of pulling 16 tons of rock, will be operated at first, but it is believed that their introduction will lead to the general use of electricity as a motive power in the mines of the Michigan district.

## The Carnegie Technical University.*

It was some weeks ago announced by the daily press as definitely settled that Pittsburgh is to have a great technical institution, especially adapted to its peculiar needs and to be made, in its industrial field, as complete and admirable as the Carnegie Institute, of that city, has become in art and æsthetics. Mr. Carnegie, who has now placed the Scotch universities in a comparatively comfortable position by an endowment of $10,000,000, and has thus contributed to the cause of liberal education more than has ever been before given by any individual in a single gift, has now determined to do something on a liberal scale for that department which most naturally appeals to his personal sympathies—education in applied sciences—and he has agreed to supply the funds for the new foundation. The organization of the institution has been entrusted to the local board of trustees, already having charge of the Carnegie Institute and the Carnegie Library at Pittsburgh. This body has appointed a committee "On Plan and Scope," and this committee, in turn, has called in experienced and expert advisers to aid them in determining upon the very best plan and the most suitable scope of the institution, and of its curriculum.

These expert advisers were Dr. R. H. Thurston, director of Sibley College, Cornell University; Professor J. B. Johnson, dean of the College of Engineering, University of Wisconsin; Professor Thomas Gray, of the Rose Polytechnic School, and Professor V. C. Anderson, of the Armour Institute. After their several reports had been made they were organized into a committee to consider and report upon the schemes of the individual reports and to present a final and condensed statement of the plan upon which all could agree. This is the report which we present herewith to the readers of *Science*. It includes, as is seen, three different and distinct forms of school which may be combined as parts of one complete technical university that might satisfy the ambition of John Scott Russell, were that greatest of promoters of industrial education living; or they may be adopted, singly or together, on any scale which the needs of the city, the opportunities of the founder and the ambition of Mr. Carnegie and his coadjutors may seem to justify.

It is understood that this is simply a recommendation of his committees and that Mr. Carnegie is in no way bound to accept either the plan, the scope or the estimated endowment as binding upon him. It is understood that the committees will report to him the plan and scope proposed for these schools, leaving him free to found a school for artisans, a technical high school or a technical college, or, if his ambition mounts so high, a true *technical university*, including them all, and more complete and universally fruitful of good to all sorts and conditions of men and women—it is understood that both sexes are to be provided for—than has been any institution for technical, industrial and scientific education, ever before conceived. Even this latter is entirely within the means of Mr. Carnegie, as limited by his publicly declared plans of distribution of funds for educational purposes, and it would be a glorious thing for the world, as well as for Pittsburgh and our country, could the ideal technical university be thus made a reality by our greatest philanthropist.

* From *Science*.

### REPORT OF THE ADVISORY COMMITTEE ON THE CARNEGIE TECHNICAL SCHOOLS OF PITTSBURGH.

PITTSBURGH, PA., June 25, 1901.

Mr. William McConway, chairman Committee on Plan and Scope.

DEAR SIR—Your advisory committee begs leave to submit the following report upon the scope of the proposed Carnegie Schools of Technology.

#### INTRODUCTION.

It has become clear, both to educators and to business men, that the new century demands a wide dissemination of a *new type of school training*. The new methods of concentrated capital and of wholesale production; the ready means of transport by which our antipodes have become both our customers and our sources of supply; the practical abandonment of both the apprenticeship system and of the individual manufacturer; the world-wide field of operations in all lines of trade; the infinite number of applications of scientific knowledge in all fields of modern industry; the whole-world competition which confines success to the most economic production; and the constant supplanting of manual labor and man power by automatic machinery and by steam or electric power; these are some of the signs of the times by which it is clear that some new kind of preparation for the work of life must be introduced into the school training of both boys and girls. This, too, not only for their individual success, but for the maintenance of American leadership in manufacturing and commerce. What this new education should be for America may be exemplified by the proposed Carnegie Technical Schools, of Pittsburgh. Nothing short of such a complete system should be planned.

The scheme which your committee proposes may be divided as follows:

1. The Carnegie Technical College.
2. The Carnegie Technical High School.
3. The Carnegie Artisan Day and Evening Classes.

#### 1—THE CARNEGIE TECHNICAL COLLEGE.

This should be a first-grade technical college, superposed upon a high-school curriculum, with entrance requirements equal to those demanded by the best grade of existing colleges of engineering. It should be a school of both pure and applied science, and should prepare young men for leadership in the commercial as well as in the industrial pursuits. Both our manufacturing industries and our foreign commerce are now demanding the highest technical training it is possible to bestow, but this training must be fitted to particular vocations.

This college should be made attractive to the greatest scholars in the fields of physical and chemical science. To obtain and hold such men they must be given ample opportunities for research. This college must be supplied, therefore, not only with great experimental shops and laboratories for students' use, but in all departments there should be splendidly equipped laboratories of investigation and research, under the direction of the head of such department, and with a full corps of assistants for the carrying on of lines of investigation which are now partly or wholly unprovided for in America. These well-equipped workshops and these experimental and research laboratories would form the chief distinction of this technical college, and they would also be the chief item of expense. The college would support one or two publications in which the fruits of this research department would be given freely to the world. While the number of students in this college would be small, as compared with the number in the technical high school, the work done here would be of far more benefit to the world, and it would form the chief, if not the only, feature of the whole scheme to attract attention and to extend its beneficent influences beyond the immediate vicinity of Pittsburgh.

Instruction in the technical college should include:

1. Technical courses in:
   - *a.* Mechanical engineering.
   - *b.* Electrical engineering.
   - *c.* Civil engineering.

*d.* Chemical engineering.
*e.* Electrochemical engineering.
*f.* Marine engineering.
*g.* Railway engineering.
*h.* Sanitary engineering.
*i.* Mining engineering and metallurgy.
*j.* Architecture.
*k.* Commerce and transportation.

2. Courses in pure and applied sciences.
*a.* Mathematics.
*b.* Physics.
*c.* Chemistry.
*d.* Biology.
*e.* Geology.
*f.* Mineralogy.
*g.* Astronomy.
*h.* Economics.
*i.* Commercial geography.

3. Courses in modern languages.
*a.* English.
*b.* German.
*c.* Spanish.
*d.* French.

2—THE CARNEGIE TECHNICAL HIGH SCHOOL.

The work of this school should be superposed upon the work of the public grammar schools of Pittsburgh and Allegheny. Its scope should be broad and comprehensive. The elective principle should be recognized, and graduation would depend not upon completing a prescribed curriculum, but upon completing a required number of courses, to be selected by the student under the direction of the director of the school.

In this school the boy who wished to fit himself for industrial pursuits would find equal advantages with the boy who desired to prepare himself for professional engineering, or the girl who wished a general high school education supplemented by instruction in the home-making arts.

To make this instruction practical and fruitful of results it would be necessary to have well-equipped shops and experimental laboratories in all the courses leading toward specific employments, and these require a liberal housing, an expensive equipment and an expert direction by accomplished artisans. Such a complete school as is here proposed does not now exist in this country, but it would prove a pattern to be copied in every large city and such as the new century and the new industrial conditions demand.

Instructions should include:

1. The ordinary English high school studies.

2. Physics, chemistry and biology, with students' laboratory practice.

3. The elements of the calculus and applied mechanics.

4. French, German and Spanish.
5. Commercial studies.
6. Domestic arts and sciences.
7. Freehand and mechanical drawing.
8. Technical studies, fitting for the industries of the locality, such as:
*a.* Blast furnace and foundry practice.
*b.* Glass making.
*c.* Brass founding and finishing.
*d.* Pattern making and joinery.
*e.* Metal working.
*f.* Stationary, locomotive and marine engine and boiler management.
*g.* Light and power station management.
*h.* Gas manufacture.
*i.* Railroad transportation.
*j.* Plumbing and domestic sanitation.
*k.* Surveying.
*l.* Clay working and ceramics.
*m.* Industrial art.

3—THE CARNEGIE DAY AND EVENING CLASSES.

These classes are proposed for the benefit of those who are unable to take advantage of the more complete courses in the Technical High School. They should be available to both sexes. Instructions should include:

*a.* Elementary mathematics.
*b.* Elementary physics.
*c.* Elementary mechanics.
*d.* Elementary chemistry.
*e.* Freehand and mechanical drawing.
*f.* Modern languages and elementary instruction in such technical subjects as are taught in the Technical High School.
*g.* Courses of special lectures on subjects of interest to artisan classes.

In conclusion, your committee desires to state that in its judgment a large tract of land, not less than 50 or 60 acres in extent, should be provided, in order that the buildings may be grouped about an attractive campus.

Furthermore, the best educational experience leads us to believe that the highest interests of these schools will be conserved by being maintained as independent institutions unhampered by public or private control.

Respectfully submitted,

(Signed) ROBERT H. THURSTON,
VICTOR C. ALDERSON,
THOMAS GRAY,
J. B. JOHNSON.

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The first sealed thermometer, which was of the alcohol type, was made about 1653 by Ferdinand II, the Grand Duke of Tuscany. Fahrenheit was the first to construct a mercury thermometer, having made one as early as 1714.

**Trolley versus Steam.**

The last Indiana Legislature by the passage of a law allowing traction companies the right of eminent domain, the same as that which has been exercised by steam railroads, in condemning land for rights of way, has given a great impetus to the building of electric railways in that state. Companies which had been unable to secure rights of way over the highways of the state are now able to get private rights of way. The passage of this law will, no doubt, make the contest between electric railways and steam railways of the state more interesting. There are now 200 miles of interurban electric railroad out of the city of Indianapolis, which connects that city with the cities of the Indiana gas belt, and there are something like 1,000 miles of electric railway at present projected in the State of Indiana. The interurban roads afford the fastest schedule for passengers, and are being largely patronized by farmers along their lines and by residents of the towns and cities between which they have been constructed.

The steam railroads have felt the effect of competition with these lines to such an extent that they have been obliged to cut local rates, and in many cases have been forced to improve their train service. Many believe that the railroads will be obliged to absorb these interurban lines, or else give up, to a great extent, their local business, as there seems to be hardly enough business for both at the present time. There is promise, however, that instead of an absorption of the electric lines by the steam lines, a consolidation of the former will take place. The Elkins-Widener people have already acquired the Union Traction Company's lines, which are most extensive in the central portion of the state, and they also control the Indianapolis Street Railway Company and the Cincinnati lines. It was reported that they have also acquired the Greenfield and Indianapolis lines. This syndicate, if its present plan of consolidation is carried out, will absorb most of these traction companies, and thereby perfect a system connecting Indiana, Illinois and Ohio.

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Experiments are being made at Brescia, Italy, with a new process for smelting ores by electricity. A 500-horse-power furnace has been installed and a commission composed of some of the best known scientists of the country is conducting the experiments. Captain Stassano, of Rome, is the inventor of the process.

### Commercial Aluminum Zinc Alloys.

No alloys containing more zinc than aluminum have any special valuable mechanical properties, even the alloy of equal parts of both. The alloy Al—2, Zn—1, reaches a tensile strength of 40,000 pounds per square inch, melts at 425 degrees centigrade, does not easily oxidize, and takes a fine finish. It closely resembles a high-carbon steel in character, and is the hardest and strongest of the Al-Zn series. Its specific gravity is 3.8. A contraction of 17 per cent takes place during alloying. The alloy Al—3, Zn—1, is the most generally useful of the series. It is softer than the last, tensile strength, 35,000. It is not malleable, but yet not brittle, bending before breaking. Hence, castings may be straightened out. Specific gravity 3.4, contraction 14 per cent; good castings are yielded. When made from pure metals it is equal to finest brass in the lathe and under the drill and fire. Its color is equal to that of aluminum. It is used for scale beams, astronomical instruments, light machine parts, testing machines, surgical appliances, etc. Below 25 per cent zinc the strengths of the alloys decrease rapidly. The 15 per cent alloy can be rolled and drawn; tensile strength 22,330 pounds per square inch.—*The Electrochemist and Metallurgist.*

### Portable Railway Storage Batteries.

The Brooklyn Rapid Transit Company, of Brooklyn, N. Y., has been utilizing some of its old cars as moving storage battery stations. Seven of the old steam passenger cars belonging to the Brighton Beach road have been equipped with 248 cells of battery each and in the summer time have been located near the race tracks at Sheepshead Bay and Brighton Beach to help out heavy traffic on those lines. Next winter they will be removed to East New York to increase the capacity of the storage substation at that point.

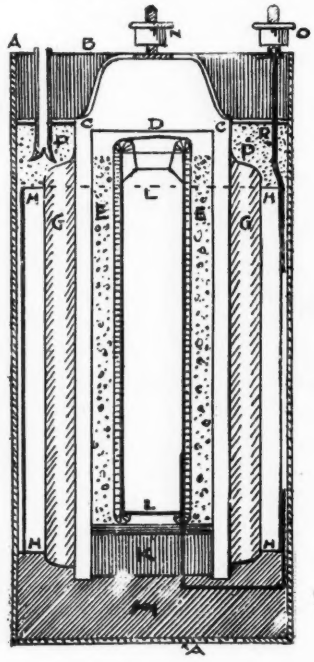
### Incandescent Lamps at Navy Yard.

The United States Navy Department has issued the following specifications for incandescent lights to be used at the Portsmouth, N. H., Navy Yard:

"All the above lamps to be of coiled filament style, short bulbs, with a guaranteed efficiency of 600 hours at three and one-half watts per candle-power, measured horizontally through the coil, full candle-power, and measured vertically to show not less than 80 per cent of the stated candle-power. All lamps to be neatly and correctly finished and first grade in all particulars. Delivery within 10 days from the date of award."

### New Type of Dry Battery.

The accompanying illustration shows a new form of dry or semi-dry battery of considerable interest. The battery consists of a central hollow carbon, which is the full height of the battery, carrying inside a hollow zinc cylinder. These are both filled with an electrolytic solution which is stated to be inactive until the circuit of the battery is closed. Outside of the cylindrical carbon is a dry-pressed polarizing composition, which is held together in a cloth receptacle. Still outside of this is a cylindrical zinc, and outside of the latter is a block tin receptacle serving to strengthen and preserve the battery and to protect it from external damage. The outer and inner zincs are connected at the bottom, as shown in the illustration. It is claimed that the battery in action is something like a wet storage cell inside of a dry cell. Its recuperative powers are claimed to be high, and the deterioration in storage very low. It is stated that a three by six and one-half-inch cell gives 23 amperes on short-circuit. The battery is made by the Hydra Double Battery Company, of New York, which concern has acquired the American rights of the original German invention.




New Dry Battery.

The New England Telephone Company is the originator of a new scheme for a telephone exchange. It is soliciting subscriptions from bankers, brokers, trust companies and banking houses, and proposes to establish an exchange for their exclusive use which will give a quicker and better service. A number of subscribers have been secured and service is promised each at a cost of $72 per annum.

### A Norwegian Power Plant.

A company of Norwegian capitalists, owning a number of waterfalls on the Glommen River, is developing one of the largest of them at Askim, near Christiania, the capital of Norway, where an enormous electrical power-transmission plant will be installed. The plant is designed to supply 45,000 effective horse-power, though the present power station is only equipped for 12,000. One thousand men have been at work on the plant for 18 months, but it will probably be 12 months before the work is finished. The power-house will be equipped with three generators, each consisting of one Francis turbine with vertical axle, direct-coupled to a three-phase dynamo for an output of 2,000 kilowatts at 5,000 volts. To each generator there belong three three-phase transformers with an output of 700 kilowatts each to transform the generator current to 20,000 volts. For extensions of the power station special 5,000 horse-power sets are proposed. The company will not only supply the city of Christiania with electric light and power, but also all industrial enterprises which may be established within 50 miles of the power plant.

### Water Power in France.

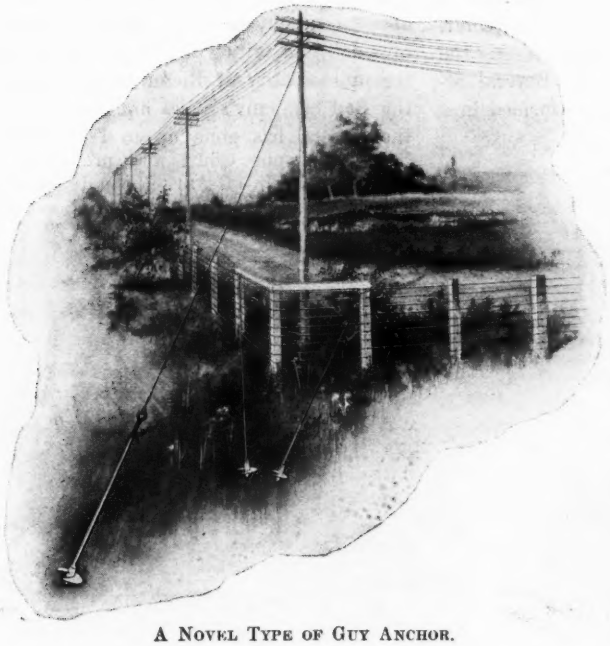
Extensive development of water power at three separate places on the Rhone River, in French territory, is promised within the next three years. Work will begin at Malpertius, a point two and one-half miles below Bellegrade, where the river has a fall of 30 feet with perpendicular banks only 160 feet apart. It is estimated that a tunnel one-half mile in length will give a fall of 51 to 55 feet which will produce 25,000 horse-power at low water. Another tunnel near Bellegrade is expected to furnish 30,000 horse-power. About eight miles from the Swiss frontier is a narrow gorge, 80 feet in width, at which a fall of 65 feet can be secured, giving 30,000 horse-power. These three plants will, when finished, give a total of 85,000 horse-power between the Swiss frontier and Pyrimont.

### Wireless Telegraph at Boston.

The Boston Chamber of Commerce is said to be considering plans to establish a wireless telegraph station at some point out at sea by which messages may be received from outgoing and incoming vessels. The station will probably be erected near the place where vessels separate to reach Boston and New York. The station will be operated in conjunction with the Maritime Exchange, of New York, with which the Boston Chamber of Commerce is now in correspondence.

### Novel Type of Guy Anchor.

The illustration herewith, which shows the appliance known as the Stombaugh guy anchor, practically speaks for itself. The anchor consists simply of a hellical screw, resembling that on a post-hole digger or earth auger, to which is attached the rod for connection with the guy wire. A simple wrench is used to put the anchor in place in the ground, or, if desired, to take it out again. It is made in various sizes from three and one-half inches up to twelve inches, and has been found exceedingly useful in guying poles of various sorts, fences, etc. The anchors are handled by W. N. Matthews & Brothers, St. Louis, Mo.



A Novel Type of Guy Anchor.

### The Boston Elevated.

One month has elapsed since the Boston Elevated Railway Company opened its lines to the public, and notwithstanding the unfavorable conditions under which a new system of such proportions must at first be operated, the service of the company has given entire satisfaction. So popular has the elevated line become that the 100 cars already put on have been found insufficient for the needs of the line, and additions must be made to this part of the equipment.

A unique feature of the management of this system is that at any of the stations, either elevated or subway, transfers are given to the surface lines. Thus each station becomes a terminal.

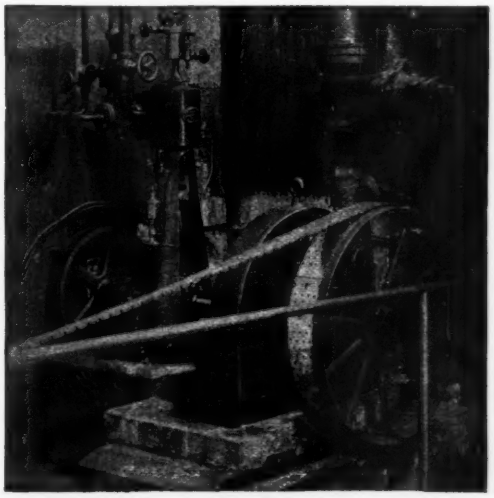
The Sprague type of equipment was installed by the Boston company and has so fully answered all requirements that a new order for 50 additional multiple-unit equipments has just been given.

### Theory of the Wimshurst Machine.

M. Bordier, in a note presented to the French Academy, has recently propounded a new theory of the oppositely rotating plate machine. Our London namesake gives the following account of his hypothesis: The particular variation of this machine he experimented with was that associated with the name of Bonetti, the peculiarity of which is that there are no tin-foil sectors on the rotating plates. The remarkable discovery that M. Bordier has made is that this machine, after it has been excited, will continue to work after the neutralizing rods have been removed. The output in the latter case is one-third less than when the neutralizing rods are present. M. Bordier attributes this peculiar action to the influence of the charges on the electrodes of the machine, but we imagine the true explanation is to be found in the experiments of Holtz (*Pogg.-Ann.*, vol. cxxx, p. 128), where he shows that when a glass surface highly charged with electricity is discharged by points, it takes on a charge of the opposite sign. This is due to the influence of the charge on the glass surface approaching the points. The discharging combs of a Bonetti machine must, according to Holtz's experiments, reverse the electric charge on the plates, and in this way perform the same function as the neutralizing rods which can, therefore, be removed without stopping the working of the machine. This action is, however, not so effective as that of the neutralizing rods, and we imagine the machine would, in the course of time, lose its excitement.

### Combined Pelton Wheel and Steam Engine.

A remarkable combination of steam engine and Pelton water-wheel is in successful operation at the Tower Waterworks, Chester, England. It is used to drive dynamos for lighting the pumping station and filter beds, and is so arranged that either the Pelton wheel or steam engine can be run separately or together, as required. The wheel is three feet in diameter, fitted with phosphor-bronze buckets of approved shape, the sides of buckets being widened out to allow the spreading of the water as its velocity diminishes. The shaft is fitted with stuffing boxes to prevent the lubricating oil from mixing with the water. This is very important, as all the water is filtered and passes on to the town mains.



Combined Pelton Wheel and Steam Engine.

Two nozzles of seven-eighth-inch diameter are fitted, but only one is generally required. The only other British installation of similar nature is the Linton & Lynmouth Electricity Works, Lynmouth, North Devon. Here Pelton wheels and turbines are used alternately. The steam engines in this case, however, are only used in cases of emergency.

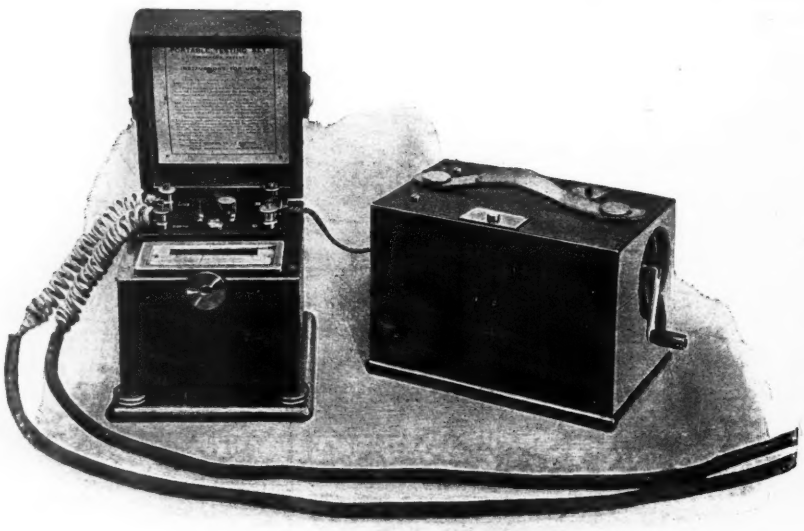
The installation here shown, as well as several others of similar type, was designed and installed by Mr. P. Pitman, of Halifax, Yorkshire.

Schlomon and Castro, of Berlin, have secured an English patent on a process for rendering water-proof textile fabrics, ropes or any porous material by passing them through a bath of zinc, copper or other metallic salt and then between a metallic table and a hinged metal plate forming the poles of a current. The metal is deposited in the material and is said to render it water-proof and non-combustible, and to fix the dyes in colored stuffs.

### Portable Testing Sets.

In the accompanying illustration is shown a testing set consisting of a direct-reading ohmmeter, which indicates by a simple scale reading the value of resistance being tested. In conjunction with it is shown a portable hand-dynamo, or generator, which provides the current necessary for the test at any required pressure.

The instrument is independent of the direction of the testing current, and reversal of the connection between instruments, or the direction of rotation of the generator, produces no effect upon it. The generator is capable of producing a potential of 1,000 volts, while its weight, it is claimed by the makers—Messrs. Queen & Company, Incorporated, Philadelphia—is considerably less than that of other similar apparatus. Its armature coils are wound in poles on the periphery of the laminated core, while the brushes take the form of elastic disks rolling in contact with the ring segments of the commutator. The gearing between the handle and the armature axle is cut from wrought brass and in every way friction is reduced to a minimum. The standard patterns of these generators are for 100, 200, 500 and 1,000 volts. A twin flexible cord of high insulation is wound upon a spring drum inside the generator case and any required amount of it can be pulled out for use. The ohmmeter is made to read from 2,500 ohms to 50 megohms in its various sizes.



PORTABLE TESTING SET AND GENERATOR.

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Accumulator electrodes for traction are made by Dr. R. A. Katz under patent 16,569, 1899, from grids of caoutchouc or celuloid filled with the active material and pressed against thin perforated lead plates.

### The Electric Motor Applied to Surgery.

The accompanying illustration shows a small Lundell motor used in the operating room in the Presbyterian Hospital, Seventieth street and Madison avenue, New York. It is a round type motor mounted on a universal bracket, and has a flexible shaft arranged with a special chuck at the end for receiving the surgical instruments used for trepanning the skull and for drilling and sawing bones. The general arrangement of supporting the motor and the method of attaching the shaft enable the motor to be operated at a very high speed with maximum power, there being no vibration when guiding the instruments with the hand. Several recent operations have been performed in a much shorter time by the use of this apparatus than is usually occupied by the old method of chopping with chisels and using ordinary hand saws. The operations are accompanied with less pain to the patient, which is an excellent argument for the introduction of this apparatus. It is claimed by the manufacturers that the superior design and construction of the Lundell motor enable special applications of this kind to be made to great advantage. The motor in this instance is of one horsepower, 115 volts and 2,200 revolutions per minute. It was manufactured by the Sprague Electric Company, New York.

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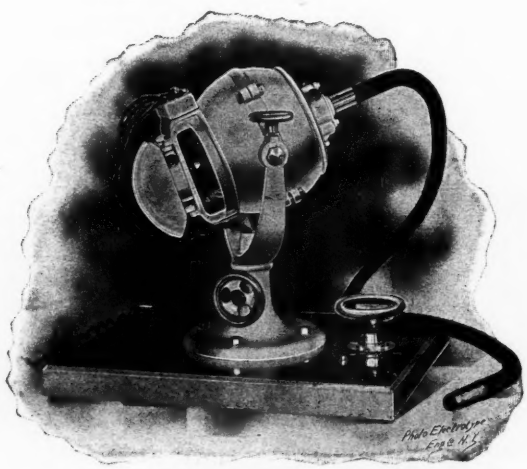
The electrical industry of Germany, according to consular reports, consumes 40,000 tons of copper annually. Of this amount only 3,000 tons, or about one-thirteenth, is produced in the German Empire.

### Telephone Affairs in Richmond, Va.

The long struggle between the Independent and Bell companies in Richmond, which is further complicated by a suit pending in the United States Supreme Court to define the status of the Bell company in the city, has resulted in the refusal of the board of aldermen to grant a new franchise for the Bell company in that city. Several years ago the Bell company's franchise lapsed and it has been running its exchange since without a franchise, under an injunction from the federal courts restraining the city from interfering with it until the status of the company could be definitely determined. The suit, which was brought by the municipality of Richmond to remove the Bell company's poles and wires from the streets, has gone up to the United States Supreme Court and promises to become a *cause célèbre* in the telephone world.



SURGICAL ELECTRIC MOTOR.

### Edison at Buffalo.

Those who are interested in the electrical display at the Buffalo Exposition will be pleased to learn that arrangements have been perfected with Mr. Edison for the exhibition of his two most recent and very valuable inventions—the new storage battery and the thermophile. As soon as these machines can be made ready they will be installed in the Electricity Building, where all who desire may see and examine them.

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It has been found that the life of a telegraph pole in the Philippines is little more than one year. The white ants which proved so destructive to the poles on the line of the Cairo-Cape system in Africa are also found in the Philippines and aid the climate in the work of destruction. Lately the experiment of attaching the wires to growing trees has been tried and found to work successfully.

# Current Electrical News

## COMMERCIAL NEWS

### DOMESTIC AND EXPORT

The city government of Amsterdam, Holland, is in the market for 140 electric cars and 5,000 tons of grooved rails for tramways. Bids will be received until September 2, and should be forwarded to the Director of Municipal Tramways, No. 164, Nieuwe Achtergracht, Amsterdam.

In South Africa the town council of East London is considering propositions to extend its electric traction system. The proposed improvements will cost about $100,000. The lines will haul freight as well as passengers, and it is probable that specially constructed motors for this purpose will be required.

The submarine torpedo boat Plunger, which was built for the United States Government and proved a failure, has been turned over to the Holland Torpedo Boat Company to be remodeled. The motive power will be changed to electricity, storage batteries being used as in the case of the Holland boats.

The Norwegian Storthing lately passed a unanimous resolution requesting the Norwegian Public Works Department to give preference to Norwegian firms in the purchase of materials needed by the department, the army and navy. The telephone was especially referred to as an article needing such protection.

A company is being organized at Saginaw, Mich., for the purpose of building heavy gas engines for electrical purposes, with special reference to direct-connected work. Mr. W. F. Loomis, who has been connected with the Olds Motor Works, is organizing the company. A new factory is being constructed, and the company will be ready for sales within a few months.

The company which proposes to develop the power of the Kern River, near Los Angeles, Cal., is to have a rival in size, if reports be true, in the Mammoth Power Company, of Oakland, Cal., which, it is said, will utilize the waters of the San Joaquin. The company will top the river at Mammoth Pool and carry the water a distance of 16 miles through a tunnel seven by eight feet to a point where a fall of 1,700 feet can be secured. The total cost of the plant will be $4,000,000.

The principal electric lighting plant of Toledo, Ohio, and all of the street car lines have been purchased by Henry A. Everett and Edward W. Moore. The properties are to be combined with a capital of $12,000,000, and will be known as the Toledo Railways and Light Company. A. E. Lang will be president of the new company, and Louis E. Beilstein, formerly superintendent of the Detroit three-cent fare lines, will be general manager. Articles of incorporation are to be filed in Columbus at once.

It is reported from Philadelphia that the death of Albert J. Johnson, notice of which was published in our issue of last week, will not put an end to the fight for a three-cent fare system in that city. Mr. Johnson's attorney, Mr. Shields, explained that Mr. Johnson was not acting as an individual in this matter, but was rather the head of a corporation. He was not able to say who would be Mr. Johnson's successor, but presumed that an election would be held at an early date. It is rumored that Mayor Tom L. Johnson, of Cleveland, may take up the fight of his brother.

The Westmoreland Light and Power Company has been organized at Greensburg, Pa. The incorporators are: E. H. Bair, E. E. Robbins, J. E. McFarland, M. L. Painter, W. S. Lane, Daniel Monahan, James K. Clarke, and D. C. Ogden. The capital stock of the company is $500,000. The new concern has absorbed the Westmoreland Electric Company, the Irwin Electric Company, and the Jeanette & Manor Electric Company. Improvements on these plants will amount to $200,000. Mr. James Bryan, of Pittsburgh, Pa., has been elected chief engineer of the new company.

The Bullock Electric Manufacturing Company, of Cincinnati, Ohio, will erect a plant in England for the manufacture of specialties for the British market. Mr. George Bullock, president of the company, has just sailed for England, and while there he will select a location for the new plant. It is said that Mr. Bullock will interest some English capital in the new concern. This is the fourth large electrical plant to be constructed in England to which American capitalists have largely subscribed. The other three are: The British Westinghouse Electric and Manufacturing Company, Limited, near Manchester; the Thomson-Houston plant at Rugby, and the McGuire Works, in which the McGuire Manufacturing Company, of Chicago, is interested.

American makers of electrical machinery gained quite a victory over foreign manufacturers in securing a contract to install an electric power and lighting plant for the Antwerp Steel Company, of Antwerp, Belgium. The Westinghouse interests will do the work which will cost $250,000, and when completed the works will be the most advanced in Europe, so far as electric lighting of steel plants is concerned. The machinery for these improvements will all be made in Pittsburgh and will be of the most modern type. The electrical plant will be arranged so that it may at any time be enlarged, and it is said that in the near future the gas from the blast furnaces of the steel plant may be used for the purpose of generating electricity for the public supply of the surrounding district.

## TELEPHONE AND TELEGRAPH

The Virginia-Carolina Telephone Company has begun the construction of a line to connect Buffalo Lithia Springs, Va., with Clarksville, eight miles away.

A telephone line is being constructed between Russellville, Ala., and the towns of Tuscumbia, Florence and Sheffield. The length of the line will be 20 miles.

A meeting of the directors of the Central Union Telephone Company will be held at Chicago to consider means of raising $3,000,000 new capital. It is said that 70 per cent of the stockholders have agreed to accept any one of the three plans recently submitted by President Sabin.

The Southern New England Telephone and Telegraph Company has begun the installation of an extensive underground conduit system in the city of Bridgeport, Ct. The work will be done in the most thorough and substantial manner and will be finished in time to "connect up" with the new exchange building now under construction.

The United Electric Company has applied to the city council of East Orange, N. J., for permission to lay conduits on Main street and Park avenue, with such extensions north and south as may be required by the demand for service. The right will doubtless be granted, as the city has for some time been making an effort to have the overhead electric wires removed.

Resolutions adopted by the board of aldermen of Paterson, N. J., at a recent meeting, require all telegraph, telephone and electric wires now strung overhead in Lane and Market streets, to be immediately placed underground. There was also some discussion as to the advisability of compelling the trolley companies to place their wires underground; no decision was reached.

## LEGAL NOTES

PASSING IN FRONT OF TROLLEY CAR—In the case of Walker *vs.* St. Paul City R. Company, the Minnesota court holds that a person seeking passage on an electric street car, who signals the car to stop, and then attempts to cross the track to get on the proper side for boarding the car, and is struck by it, is not guilty of negligence as a matter of law, but has a right to assume that proper signals will be regarded.

TELEPHONE COMPANY'S DUTY OF INSPECTION—Patrick McGuire, a lineman, was thrown to the ground by the breaking of a pole which, it appeared, was rotten in the interior. Damages were awarded him, the Court holding that the company owed a duty to its linemen to see to it that a proper inspection was made of the poles to see that they were capable of supporting the men while at work. This decision of the Court of Appeals was dissented from, however, by Chief Judge Parker, who held that the person using a pole, building or system, put up on the property of another as a mere licensee—as was the case in this instance—is not bound to establish a system of inspection and repairs in regard to such property in order to protect employés from injury because of a hidden defect only discoverable by a system of inspection involving the necessity of dominion over the property.

MUST HAVE TIME TO BOARD CARS—William F. Fay took hold of the upright rail of a Broadway car, and just as he placed his left foot on the step the car gave a sudden jerk and Mr. Fay was thrown into a hole in the street. Justice Ingraham, in the Appellate Division, New York, held that the dismissal of Mr. Fay's suit for damages against the Metropolitan Railway Company was an error, saying: "The defendant was bound to give the plaintiff a reasonable time to board the car, and the evidence would have justified finding that the defendant was negligent in that respect; nor do I think that the plaintiff was, as a matter of law, guilty of contributory negligence. Having hold of the car about to board it, when the car suddenly started, there was presented an emergency which required the exercise of judgment as to the best course to avoid being injured. If to avoid being thrown down by the sudden starting of the car, he held on to the car to steady himself until he could let go in safety, it was certainly not negligence as a matter of law. But for the existence of this trench in the roadway alongside of the track, which he had not observed, he would probably have escaped injury by adopting the course that he did, but his falling into the trench was caused by his being dragged along by the car. There can be no doubt that the starting of the car was the proximate cause of the injury."

## ELECTRICAL SECURITIES

Perhaps the explanation for the general decline in the value of industrial stocks during the past week may be found in the general liquidation of stocks which has gone on through the week, probably because of speculative holdings by people who have waited too long for a rise. A general alarm concerning the condition of the Middle West, which is suffering a severe drought and extremely hot weather, and the prospects of an extended strike in the steel industry have both had their share in causing a general lowering of prices. The reaction which has followed the upward boom of stocks was not expected or unnatural and, notwithstanding the general decline, the market is in a healthy and, for the summer time, a fairly active condition.

ELECTRICAL SECURITIES FOR WEEK ENDING JULY 13.

| *New York:* | Highest. | Lowest. | Closing. |
|---|---|---|---|
| B'klyn R. T. | 82½ | 74¾ | 76 |
| Con. Gas. | 224 | 210¼ | 213¾ |
| Gen. Elec. | 265 | 246¾ | 249 |
| Man. El. | 123 | 115 | 116½ |
| Met. St. Ry. | 173 | 165½ | 160 |
| Third Ave. R. R. | ... | ... | 123 |
| Kings County Electric. | ... | ... | 205 |
| N. Y. & N. J. Tel. Co. | ... | ... | 175 |
| Telep., Tel & Cable Co. | ... | ... | 6¼ |

The London *Statist* in its issue of July 13 says: "The figures of our own trade with America conclusively show the enormous profits which the United States are making in foreign trade. For the first six months of the present year our imports from the United States have been nearly £69,000,000, as against a little over £59,000,000 in 1900, while our exports to the United States were worth only £7,000,000, as against £8,300,000. This means that for the year to June 30 we have bought £148,000,000 in produce of the United States, while it has bought of us £18,000,000. The trade balance in favor of the United States, as respects England, was £130,000,000 as against £119,000,000 for the calendar year of 1900. . . . It appears certain that we shall have to supply considerable gold to the United States, and that the value of money in London will advance."

The General Electric directors held a meeting at noon July 12, and the question of restoring the capital stock to its former amount was brought before the meeting. No definite action was taken.

A persistent rumor has been in circulation that an immense telegraph combination would be formed, with the Western Union company as the parent concern. It has not been possible so far to obtain official information regarding the rumor.

| *Boston, July 13:* | Closing. |
|---|---|
| Am. Tel. and Tel. | 154 |
| Erie Tel. | 51 |
| New Eng. Tel. | 140 |
| Mass Elec. pf. | 93½ |
| Westing. Mfg. pf | 79½ |
| Edison Elec. | 260 |

The Edison Electric Illuminating Company of Boston has declared a regular quarterly dividend of two and one-half per cent, payable August 1 to stock of record July 18.

The American Telephone and Telegraph Company's statement for the month ending June 20 breaks all records, as regards the gross and net output of instruments. The best previous record was in March, 1899, when the output was 53,503. Last month's statement showed 96,300 instruments put out and 34,221 returned. This is regarded as indicative of good general business conditions throughout the country. The total outstanding number of telephones to-day is 2,228,107.

Up to date 10,000 shares of the Boston Electric Light Company, out of 30,000 outstanding shares, have been deposited with the Old Colony Trust Company under terms of consolidation with the Edison Electric Illuminating Company. The stockholders have until July 24 to make further deposits.

| *Philadelphia, July 13:* | Closing. |
|---|---|
| Elec. Co. of A. | 7 |
| Philadelphia Elec | 5 |
| Union Traction | 26¼ |
| United G. I. Co. | 113¼ |
| Elec. Sto. Bat. c. | 75 |
| Elec. Sto. Bat. pf. | 75 |

The net income of the Electric Storage Battery Company for the year ending December 31, 1900, was $1,317,865. The company has paid a one and one-quarter per cent quarterly dividend on its stock and that of the Electric Vehicle Company.

Electric Company of America, whose directors met on July 10, declared a dividend of 25 cents per share, this being three and one-third per cent on the paid-in value of the stock out of the earnings for six months ending June 30. Dividend is payable July 31, books closing July 20.

| *Chicago, July 13:* | Closing. |
|---|---|
| Chicago Edison Light | 178 |
| Central Union Telephone | 36 |
| Chicago Telephone | 275 |
| Un. Trac. | 20 |
| Un. Trac. pf. | 61 |
| Metropolitan El. | 89 |

The directors of the Central Telephone Company will meet July 31 to consider plans for raising $8,000,000 new capital.

## ELECTRIC LIGHTING

An electric light plant is to be established at New London, Iowa.

An electric plant and waterworks will be constructed at Tullahoma, Tenn., to cost about $35,000.

Midland, Ontario, has voted a bond issue of $18,000 to extend and improve its electric lighting system.

A new electric light plant to furnish 240 arc and 6,000 incandescent lights is planned for Santiago, Cuba.

The board of public works of Nashville, Tenn., has let the contract for the erection of an electric light plant in that city.

The two electric light companies of Clinton, Ill., have been consolidated and are now under the control of the Clinton Gas Company.

Dalton, Ga., will hold an election on July 24 to vote on the question of issuing bonds for the construction of an electric plant to cost $30,000.

The directors of the Boston Electric Light Company have elected Everett W. Burdett treasurer, succeeding Samuel S. Sias, deceased.

New Baltimore, N. Y., will soon be lighted by the Ravenna Electric Company, which is to establish a plant at Coeymans. It is probable that the latter village will also be lighted by the same company.

The Cincinnati Gas and Electric Company is planning to remodel the building at Fourth and Plum streets. A large building will be erected in the rear and the offices of the Edison company will be moved there.

The York Haven Water and Power Company, of York Haven, Pa., which is developing power from the Susquehanna River, is rapidly progressing with its work, and will receive bids for electric equipments about August 15. The estimated cost of the plant is about $1,500,000.

A movement was started by the citizens of Great Neck, N. Y., to light the town with electricity instead of kerosene oil lamps which are used at present. Oil lighting costs the town $1,000 a year and it has been found that an electric system of lights can be installed at an expense of $600 per annum.

Arrangements are being made to begin work on the construction of an electric plant on the Chattahoochee River, at a point eight miles from Atlanta, Ga., the cost of which will be $1,000,000. J. W. English, of Atlanta, and F. W. Montgomery, 52 Broadway, New York, are at the head of the enterprise.

The Mayor of Rochester, N. Y., has vetoed the ordinance granting permission to the Citizens' Light and Power Company to lay conduits on Mill street in that city. The Mayor's reasons were, opposition to tearing up the pavement again, opposition to a second subway, and a belief that the city should own the subway to be used by all companies.

On June 15, six tenders for supplying electric street lighting for the city of Montreal were opened. The Royal Electric Company, which supplies the lighting at present, offered a reduction, which, if accepted, would save the city some $25,000 annually. Its offer was $95 per arc lamp a year for a period of either five or ten years. The Lachine Rapids Hydraulic and Land Company made the same offer of $90 per light; the Standard Light and Power Company, $99 per light; the Imperial Electric Light Company, $85 per arc light per annum for five years and $80 for 10 years; the Shawingan Water and Power Company, $79.93½ per arc light for five years or $78.47½ per arc light for 10 years; the St. Lawrence Power Company, $54.75 per arc light for five or 10 years. The aldermen of the city now have the several bids under consideration.

## ELECTRIC RAILWAYS

The Fort Wayne, Ind., & Southwestern Traction Company sold its Fort Wayne & Marion line to a syndicate.

A company is being formed to build an electric railway from Kansas City, Mo., through the towns of Liberty, Excelsior Springs, Richmond and Lexington.

Work on the new belt line to be built by the Terminal Railway Association, in St. Louis, Mo., for the purpose of carrying visitors to the World's Fair site, is expected to begin within a week or 10 days.

The Everett-Moore Syndicate, Toledo, Ohio, has closed a deal for the purchase of the Toledo, Fremont & Norwalk Electric Railroad. This gives the syndicate a continuous line from Detroit to Cleveland.

One hundred car loads of ties have been delivered to the company constructing the electric car line between Ann Arbor and Detroit, Mich. The work of grading the road has begun and will be rapidly finished.

A company has been formed with W. B. McKinley, of Illinois, president; S. L. Nelson, of Wichita, Kan., vice-president and manager; W. B. Macomber, of New Hampshire, as treasurer. Three million dollars will be spent by the company for constructing lines throughout northern Indiana.

The delivery of steel rails and other materials for construction of the Michigan & West Shore Traction Company's line from South Haven to Benton Harbor along the shores of Lake Michigan will begin at once. The chief engineer promises that the road shall be in operation by November next.

The bids for grading the line of the Seattle, Tacoma & Interurban Railway were opened last week at Seattle, and it was found that the figures of three contractors were so close together as to lead the management to make a canvass of the same before awarding the contract. This canvass will be made and the contract will be let at once.

The Rapid Transit Company, of Atlanta, Ga., which has been making an effort to secure franchises through certain streets of that city, was granted the franchise which it asked last week. The company refused to accept same, however, because the board of aldermen included in the grant a provision that three and one-third cent fares should be charged.

## ELECTRIC RAILWAYS

The road bed is being graded for an electric line between Alliance and Sebring, Ohio.

Capitalists in Franklin County, Pa., are asking the town of Waynesboro for a franchise to construct a line in that place.

Survey has been made and stakes driven for the track of the Toledo, Fostoria & Findlay Electric Railway.

It is said that work on the Centre & Clearfield, Pa., Street Railway Company's trolley road will begin at once.

Two electric railway companies are asking franchises of the city council of Iowa City, Iowa, to enter that city with an electric railway from Cedar Rapids.

The new trolley line from Graff to Rosston, Pa., has just been surveyed. The Kittanning & Ford City Street Railway Company will probably build the new line.

The company operating the Utica, N. Y., Belt Line & Suburban roads has purchased the Herkimer, Mohawk, Ilion & Frankfort Electric Railroad.

The New Paltz & Poughkeepsie, N. Y., Traction Company will extend its lines from New Paltz to Rifton as soon as rights of way can be secured from the property owners along the line.

The Utah Sugar Company, Lehigh, Utah, will construct an electric plant for lighting and power purposes and will also build a system of electric railways throughout the valley in which its property is located.

The Detroit Construction Company, which is building the Grand Rapids, Holland & Lake Michigan Electric Railway, expects to be operating cars between Grand Rapids and Holland by the first of August.

Hyatssville, Md., has been selected as the point at which a large power-house will be constructed to operate a number of electric plants in that part of the state. Construction of the building will commence at once.

The Southern Ohio Traction Company is preparing to construct a central power station in Dayton, Ohio. Permission has also been granted the company to make an extension in its lines.

It is said that the London City Council has decided to spend over $10,000,000 on new electric traction routes in that city and on the widening of streets made necessary by the construction of the new lines.

Rights of way have been procured from property owners along the route of the line to be built from Clinton to Westmoreland. A survey of the line will be made and work will be started at an early date.

An electric railway between Marion, Ind., and Salina, Ohio, is projected, the purpose being to connect the Big Interurban Electric Railway system of Ohio with the Union Traction Company's system of Indiana.

At Austin, Tex., a charter has been granted to the Blackwell, Enid & Texas Railway Company to construct an electric railway in Vernon. The capital stock of the concern is $20,000. The road will later be extended to Enid, Oklahoma Territory.

The city council of Gainesville, Ga., has granted a franchise to the Gainesville & Dahlonega Railroad Company to build an electric street railway in Gainesville. Surveyors of the company have also been at work on the line between these towns.

Capitalists of La Crosse, Wis., propose to erect an electric railway between that city and Neillsville in the same state, a distance of 75 miles. S. Y. Hyde, Colonel F. A. Copland, W. W. Cargill and A. Hirshheimer are at the head of the scheme.

Oil City and Franklin, Pa., are to be connected by a new trolley line. A force of 300 men has been put to work grading and constructing tracks. It is expected that the work will be completed by the end of August.

A company is being organized at Rayne, La., to operate an electric railway between that town and Crowley, a distance of six miles. Dr. R. C. Webb and Mervin Kahn, of Rayne, and A. W. Burden, of New Orleans, are interested in the scheme.

Another electric railway line which is proposed for the Adirondack section is one to be built from Westport, on Lake Champlain, to Elizabethtown. The route has been surveyed and rights of way can be easily secured.

The electric railroad connecting Glens Falls, N. Y., with Lake George has been completed and cars were started on regular schedule July 11. The trip from Albany to Lake George by trolley can now be made without break.

A franchise has been granted for the construction of an electric railroad from San Jose, Cal., south along the public highway to the town of Gilroy, a distance of 30 miles. At Gilroy two branches will be constructed, each about 10 miles in length.

Surveyors are at work on a line for a new electric railroad to connect Rochester and Syracuse, N. Y., and also to connect with electric roads to be built in the most important villages between these cities. The necessary franchises have been secured.

Massachusetts capitalists are considering plans for the construction of a large power plant at the falls of the Merrimac River, near Goff's Falls, Mass. The object of the enterprise will be to furnish power for a number of industries to be established in that vicinity.

A movement is on foot in Chattanooga, Tenn., to build an electric air line between that city and Nashville. It is proposed to do a general freight and passenger business, competing with the steam railways between the two points. Detroit capitalists are backing the scheme.

The Ohio Rapid Transit Company, which has franchises giving it access to every suburb within 25 miles of Wheeling, W. Va., including a territory which has a population of nearly 200,000 people, has secured a contract with the Pennsylvania Railroad for the use of its Ohio River bridge at Wheeling.

M. J. Mandelbaum & Company, Cleveland, Ohio, have purchased the Hamilton & Lindenwall Electric Traction Company's lines at Hamilton, Ohio. The price paid was $225,000 cash. The line will probably be consolidated with the Southern Ohio Traction Company and the Miami & Erie Canal Transportation Company.

The managers of the Consolidated Street Railway Company, of Utica, N. Y., have decided to inaugurate an express system along the lines which they control. The equipment will include two large baggage cars, and it is proposed to handle all parcels, bundles, trunks, etc., of the patrons of the road.

Fred T. Ley & Company, Springfield, Mass., have been granted a contract for building 42 miles of the Berkshire Street Railroad, which runs from Cheshire to Great Barrington golf grounds. The contract requires the completion of the work within six months or a forfeit of $100 per day after that time, with a bonus of $100 per diem if the road is built before that time.

It is stated that the intention of the new Yerkes company is to install a traction system in the present London underground railway exactly similar to that used on the Chicago elevated lines. The antiquated cars at present in use are to be replaced by those of the American type. New stations will be built, arc lights installed, and the road remodeled throughout.

The Marysville, Delaware, Sunbury & Mt. Vernon Railway has been incorporated at Columbus, Ohio, with a nominal capital stock of $10,000. It is said that the stock will be increased to $1,000,000 as soon as the organization is completed. The line extends from Delaware to Mt. Vernon by way of Sunbury, Galena, Centerburg, Mt. Liberty, and will connect with the Columbus, Delaware & Marion lines at Delaware.

Sioux City, Iowa, expects to be connected with Omaha, Neb., by trolley. The promoters of the scheme have interested capitalists from the East, and the preliminary steps have been taken to begin construction. The company will be capitalized at $2,000,000, and it is believed the line will cost about $1,000,000. Power will be furnished from Sioux City and Council Bluffs with a supply plant at Onawa.

Another interurban railway company is promised the citizens of Indiana. The organization will be known as the Indianapolis, Danville & Western Traction Company, and it is proposed to construct a line from Indianapolis to Danville, and later to other points west. The capital stock is given at $10,000. The directors and stockholders are David Cohen, Henry Leister, W. T. Williams, Walter Dinkleman, all of Cincinnati, and George W. Gribbon, of Dayton, Ky.

The Catskill Mountain Traction Company has been incorporated at Albany, N. Y., with a capital of $300,000. It will construct a street surface electric road 15 miles in length, from the docks at Saugerties to a point where the railroad of the Otis Elevating Railroad Company intersects the public highway running from Palenville to Cairo. It is expected that the new road will shorten by one hour and a half the time between New York city and the resorts of the Catskill Mountains.

The New York & Portchester Railway Company has completed plans and specifications for a four-track electric line from the Connecticut line at Portchester, through the towns of Mount Vernon, Pelham, New Rochelle, Larchmont, Rye, and Harrison, to connect with the rapid transit systems of Manhattan in the upper part of the city. The company promises a 54-minute schedule between the City Hall, in New York, and Portchester at about one-third the present cost.

It is reported in Toronto, Ontario, that a deal will probably be consummated which will have for its object the amalgamation of all the gas, electric light, street railway and power concerns within 100 miles of Niagara Falls. New York, Toronto and Montreal capitalists are behind the new scheme, which will be a Canadian copy of the International Traction Company, of Buffalo, Tonawanda & Niagara Falls, and will likely be controlled by the same interests. The entire system will be operated from Niagara Falls.

The company which proposes to build an electric freight and passenger line between Columbus, Ohio, and Pittsburgh, Pa., *via* Wheeling, W. Va., is securing franchises through the different counties along the proposed route. The line will be of standard gauge and as far as possible will be built on private rights of way. Large cars will be run carrying express, mail and light freight, as well as passengers. The company also proposes to furnish electric light and power to farmers and towns along the line within a mile or so of the track.

## AUTOMOBILE NOTES

At Long Branch, N. J., on July 5, Alfred C. Bostwick, of New York, broke the world's automobile record for one mile. He was giving an exhibition spurt of three miles, which he covered in the remarkable time of 3 minutes 52½ seconds. The second mile broke the record and was made in 1.16¾.

An English physician, practicing his profession in the country, writes to the *Lancet* that he has found the automobile more satisfactory than the horse. Comparing his expenses when he used a horse with those when using the automobile, he shows that the annual cost of making his visits with the former was $250, with the latter it was $125.

Mr. W. K. Vanderbilt, Jr., has received a new racing automobile, which he purchased while abroad. The machine was made in Germany, and is said to have a speed of 75 miles an hour. Mr. Vanderbilt is president of the National Automobile Racing Association, and last year, in his White Ghost, won the championship in the Newport races. This new German machine, which is much larger than the White Ghost, is expected to make a new record this season.

The Sturgis Company, of Los Angeles, Cal., has recently completed a very large gasoline automobile truck, carrying a four-cylinder, 40-horse-power motor. It is stated that the truck can handle a weight of 10 tons, half of this being on the truck itself, and half on another one towed behind. The vehicle weighs five tons and is said to carry its full load up a 16 per cent grade. All of the transmission is by gearing, and the frame is constructed of structural steel.

In a recent address delivered in London by Hon. Charles Rolls, a prominent automobilist, some interesting facts were related. Speaking of the use of the motor in the conveying of freight, he said that a ton of goods could be transported in England, a distance of 40 miles, for $1.50. In South Africa, the speaker said, the motor car had given conclusive proof of its superiority to other military transports. There was one machine running between Pretoria and Commando Nek, a distance of 26 miles, which did the work for $18 that had formerly cost $1,200. In placing this machine in service, 960 trek oxen were done away with.

The Automobile Club of America will hold a 500-mile contest during the week beginning Monday morning, September 9, 1901, which will consist of a run from the Club House, Fifth avenue and Fifty-eighth street, in this city, to the city of Buffalo. It is the purpose of the club to make this an endurance, and not a speed, contest, in order that the various types of motor carriages may have opportunity to demonstrate their "reliability and enduring qualities in a practical road contest." Mr. S. M. Butler, 753 Fifth avenue, New York, is secretary of the committee which has charge of the contest, and will furnish any information in regard to same which may be desired.

The intensely hot weather which prevailed in every section of the country during the first week of July afforded an excellent opportunity for the automobile to show its superiority to the horse carriage in the ambulance work of the large cities. Nearly all the hospitals were crippled by the exhausted condition of their horses and automobiles had to be secured. Reports generally show that the work of the automobiles was superior to that of the horses in every respect. In some cases it was affirmed that one motor carriage did the work of three horse ambulances. It is probable that the same superiority would be shown on the paved streets of our cities in cold snowy weather.

## PERSONAL MENTION

MR. C. A. COFFIN, president of the General Electric Company, and Vice-President Eugene Griffin, of the same company, returned last week from Europe.

PROFESSOR TUDOR ANDERSON, of the University of Mississippi, has been elected to the chair of electrical engineering in Tulane University at New Orleans.

MR. HARRY J. CLARK has accepted the position of chief engineer of the Oneida Construction Company, which is to build an electric line between Syracuse and Utica.

MR. W. H. ABBOTT, formerly connected with the Stanley Electric Company, of Pittsburgh, has been made consulting engineer for all its lines by the Pomeroy-Mandelbaum Syndicate.

MR. F. S. PEARSON, consulting engineer of the Metropolitan Street Railway Company, of New York, has returned from Brazil, where he has been looking into the extension of the Sao Paulo Electric Tramway and Power Company.

MR. GEORGE WESTINGHOUSE, JR., who was lately elected president of the British Electric and Manufacturing Company, Limited, who arrived in this country from Europe a fortnight since, has sailed again for England.

MR. C. L. EDGAR, general manager of the Boston Electric Light Company, sailed last Wednesday for Europe for a two months' vacation. The purchase of the Boston Electric Light Company has been practically consummated and Mr. Edgar has taken the opportunity to enjoy a needed vacation.

MR. GEORGE P. ROUX, of Havana, Cuba, has severed his connection with the firm of Delaport & Roux, and will enter the electrical trade on his own account as an electrical consulting engineer and contractor. He reports that the prospect for electrical development in Cuba is very great. He has just secured two contracts for fair-sized plants for the electrical transmission of power.

## INDUSTRIAL ITEMS

THE ELECTRIC APPLIANCE COMPANY is placing on the market a new dry battery, to which it has given the name Eaco. This battery is constructed to meet the requirements of telephone and other work where hard service is required.

THE GARVIN MACHINE COMPANY, New York and Philadelphia, is sending out a circular calling attention to the large stock of second-hand machinery which the firm offers for sale. The company also has on hand, for immediate delivery, over 400 new machine tools of every description.

A "SYNOPSIS" CATALOGUE of the S. K. C. system, which means the electrical system manufactured by the Stanley Electric Company, of Pittsfield, Mass., has just been issued. This is a small catalogue, convenient to mail in the ordinary letter envelope, and illustrates the salient points and features of the system with great distinctness and clearness. It is sent on application.

THE BRIDGEPORT BRASS COMPANY, 19 Murray street, New York, N. Y., has recently issued a very unique folder illustrating its phono-electric wire. The folder is printed in four colors, showing a design of a trolley car giving the illuminating effect at night. In the circular it announces that phono-electric wire has no hard skin to become destroyed by arcing, and for this reason its tensile strength is not impaired.

THE SPRAGUE ELECTRIC COMPANY reports a satisfactory demand for its products all along the line. Especially is this noticeable in the company's large sale of Lundell fans. The Lundell motors and split-pole generators, which are now being made in sizes up to 1,000 horse-power and 1,000 kilowatts, respectively, are in great favor with light and power companies. Increased sales are also reported in the Greenfield interior conduits and cables.

THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD has just issued No. 28 of its famous "Four-Track Series." This number consists of an attractive folder with two up-to-date maps—one of Asia, the other a comprehensive map of the Chinese Empire. In addition to these maps the folder contains much valuable historical and commercial data which entitle it to a place among the reference papers of every man with a business and of every student.

THE J. JONES & SON COMPANY, of 64 Cortlandt street, New York, are placing on the market a little dynamo which is called "The Franklin." It is designed for amateur construction and will be found of great aid to the electrical student, furnishing practical experience in construction and winding. The complete machine only weighs five and a half pounds and will drive a sewing machine or dental engine. When run as a generator it will furnish sufficient current for six 6-candle lamps.

THE BROWN & SHARPE MANUFACTURING COMPANY, of Providence, is mailing, to those who wish it, a neatly printed pamphlet entitled "Here and There in Our Shops." It is devoted to views in the different departments of the company's large plant, and gives a brief history of the growth of the same with a description of some of the methods employed in manufacturing. The company announces that its works will be closed from August 3 to August 17, for annual vacation and repairs, but during that time the office will be kept open and all orders received will be promptly filled.

THE DE DION-BOUTON MOTORETTE COMPANY is issuing an exquisite little red book entitled "Something About Motorettes." Besides giving full information concerning the various types of machines which this company makes, the little volume contains three well-written stories of travel. One of these stories is entitled "From Paris to Versailles and Back," another, "A Sixteen Hundred Mile Trip Over American Roads," and another, "Record of a One Thousand Mile Tour of Great Britain." These little travel tales are delightful contributions to the automobile literature of the day.

THE ELECTRIC STORAGE BATTERY COMPANY, of Philadelphia, which manufactures the chloride accumulator, has recently secured its 122d order from the United States Government. The new installation is to be made at Fort Hancock, N. J., and will consist of a battery of chloride accumulators of 64 elements type 19-G, installed in tanks suitable for an ultimate increase to 23 plates. This battery is to be utilized as a reserve for the operation of the gun and motor batteries, and to be regularly used for the furnishing of current for lighting quarters at night.

THE AMERICAN ELECTRIC FUSE COMPANY, of Chicago, has purchased all the rights of manufacture and sale on the patents of Chas. A. Rolfe, and will, in future, be the sole manufacturer of Rolfe specialties and protectors. These protectors have stood every test of the National Board of Fire Underwriters and have been adopted by that body. The business of the Rolfe Electric Company will be transferred to the American Electric Fuse Company, and the latter is making preparations to put the Rolfe protectors and other devices on the market in large quantities and at much lower prices than ever before. All correspondence relating to the Rolfe protectors should in future be addressed to the American Electric Fuse Company, Factory, Adrian, Mich.

# List of Electrical Patents Issued Last Week

[Specially reported for this journal by E. S. Duvall, solicitor of patents, Loan and Trust Building, Washington, D. C. Copies of any patent may be secured for 10 cents each.]

ISSUED JULY 9, 1901.

677,848 Electric railway; F. M. Ashley, New York, N. Y.—A main conductor insulated by a cord or rope wound around it, the spirals of which are arranged at a long pitch to leave bare portions of the conductor between them, and a tube through which the insulated conductor passes, and contact devices passing through the tube to make contact with the bared portions of the conductor.

677,849 Electric railway; F. M. Ashley, New York, N. Y.

677,862 Coil for electromagnets and insulating material therefor; E. F. Dwyer, Lynn, Mass.—A coil for an electromagnet, having one or more layers of grooved insulating material, and a conductor laid in said grooves and held in position thereby.

677,873 Electric arc lamp; P. Luhr, Orange, N. J.—An enclosed arc lamp, containing a gas check with one or more passages for air and gases, and provided with means for creating a draft or circulation at the mouth of the said passage or passages.

677,891 Controlling apparatus for elevators; E. R. Carichoff, East Orange, N. J.—Consists of the motor, relays controlling the operation of said motor, station limit-switches, and means for operating them from some moving part of the apparatus, the switches being arranged to break the circuits before the car reaches the desired station.

677,909 Construction of electric motors; J. J. Wood, Fort Wayne, Ind.

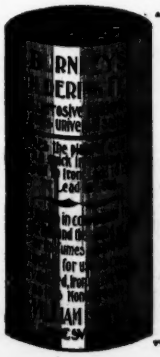
677,917 Arrangement of non-inductive windings; E. Arnold, Carlsruhe, Germany.

677,923 Electric switch; N. C. Bassett, Boston, Mass.—A pivoted switch member and a plurality of spring devices for returning said member to its "off" position from either direction, each of said devices being so mounted that it is inoperative in one direction of movement of the switch member, and each comprising two members normally maintained in engagement by a spring connection.

677,941 Rheostat; F. E. Case, Schenectady, N. Y.—A resistance ribbon wound longitudinally in a zig-zag manner, heat conducting and radiating bars between the turns of the ribbon, and two separate incombustible insulating supports, provided with slots for the reception of the plate formed by the ribbon and radiating bars.

677,954 Automatic fire-alarm; H. Cortland, Pittsburgh, Pa.

(Continued on page 32.)

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## PATENTS.

(*Continued from page 31.*)

677,955 L. G. Cunningham, Shellrock, Iowa.

677,957 Electric meter; A. G. Davis, Schenectady, N. Y.—A shaft, a step-bearing for supporting said shaft, and means for rotating said bearing.

677,966 Surface-contact railway; P. Farnsworth, Schenectady, N. Y.

677,970 Transformer; J. J. Frank, Schenectady, N. Y.

677,980 Maximum current-indicator; C. D. Haskins, Schenectady, N. Y.—Comprises a plurality of fusible filaments arranged in multiple.

677,985 Electric arc lamp; D. Higham, Winthrop Highlands, Mass.—Consists of feeding mechanism, a body of elastic fluid adapted to be compressed in response to movement of said feeding mechanism and a current-varying device responsive to variations of pressure of said elastic fluid.

677,986 Process of making accumulator electrodes; H. F. Hobel, Berlin, Germany.

678,029 System of motor control; W. B. Potter, Schenectady, N. Y.

678,030 Electrical conductor; E. D. Priest, Schenectady, N. Y.

678,047 Induction coil; Harry Shoemaker, Philadelphia, Pa.

678,058 Electric arc lamp; C. P. Steinmetz, Schenectady, N. Y.—Consists of differentially acting coils, connected so as to respond, with different degrees of promptness, to variation of current in the arc, and arc-regulating mechanism operatively related to said coils.

678,069 Starting device for constant-current apparatus; C. H. Van Slyck, New York, N. Y.—A constant-current regulating device having a movable member, an electromagnetically-controlled locking device for said member.

678,075 Preventing creeping in recording wattmeters; F. G. Vaughen, Schenectady, N. Y.—A meter-motor provided with a removable retarding device for periodically arresting the creeping of the motor.

678,086 Electric railway system; G. T. Woods, New York, N. Y.

678,095 Electrically operated musical instrument; H. S. Brown, New York, N. Y.

678,116 Electrical annunciator; C. J. Kintner, New York, N. Y.

678,133 Electrode for secondary or storage batteries; J. Myers, Hoorn, Netherlands.

678,135 Electric signal; J. J. Ruddick, Newton, Mass.

678,142 Electric arc lamp; W. E. Symons, Rhiwderin, England.

678,157 Dynamo-electric machine; B. Bjarnson, Seattle, Wash.

678,167 Means for controlling electric motors; A. G. Davis, Schenectady, N. Y.—A vehicle, a fluid-compressor thereon, a driving motor or motors geared to wheels of said vehicle, and a motor connected to said fluid-compressor and arranged in circuit with said driving motor or motors.

678,168 Magnet-coil; H. F. T. Erben, Schenectady, N. Y.

678,171 Commutator for electric machines; H. Geisenhoner, Schenectady, N. Y.—Consists of a support and segments, a clamping-ring which is stationary with respect to the support, two adjustable clamping-rings, and means for adjusting both of said rings toward the stationary ring from the outer end of the support.

678,178 Synchronizing alternating-current machines; E. M. Hewlett, Schenectady, N. Y.

678,180 Switch for electric lights; H. Horn, Philadelphia, Pa.

678,185 Protecting generators in transmission plants; T. J. Johnston, Schenectady, N. Y.

678,191 Alternating-current dynamo; D. M. Moore, Newark, N. J

678,195 Third rail insulator; W. B. Potter, Schenectady, N. Y.—A body of insulating material, a metal cap on said body, and an intervening layer of alloy which expands on cooling.

678,196 Electric control system; W. B. Potter, Schenectady, N. Y.

678,208 Enclosed arc lamp; C. H. Way, Lansing, Mich.

678,213 Electric railway; J. M. Anck, Philadelphia, Pa.

678,236 Electric measuring instrument; W. C. Fish, Lynn, Mass.

678,255 Process of regenerating accumulator electrodes; J. Hoffmann, Berlin, Germany—Consists in subjecting such electrodes to the action of a solution of free hypochlorous acid.

678,260 Ratchet operated electric switch; W. Kingsland, London, England.

678,263 Electric cloth-cutting machine; R. E. Leve, New York, N. Y.

678,289 Compound alternator; C. P. Steinmetz, Schenectady, N. Y.

678,302 Vacuum tube lighting; D. M. Moore, Newark, N. J.

678,304 Telephone circuit; W. E. Pembleton, Wittenberg, Wis.

678,312 Electric conveyor; J. G. Gilmer, St. Petersburg, Fla.

678,314 Electrical water heater; H. M. Hill, St. Louis, Mo.

678,320 Incandescent electric lamp; A. H. Miller, Chesaning, Mich.

678,344 Method of operating electric arc lamps; P. Luhr, Orange, N. J.

678,353 Inductance coil; H. Shoemaker, Philadelphia, Pa.


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